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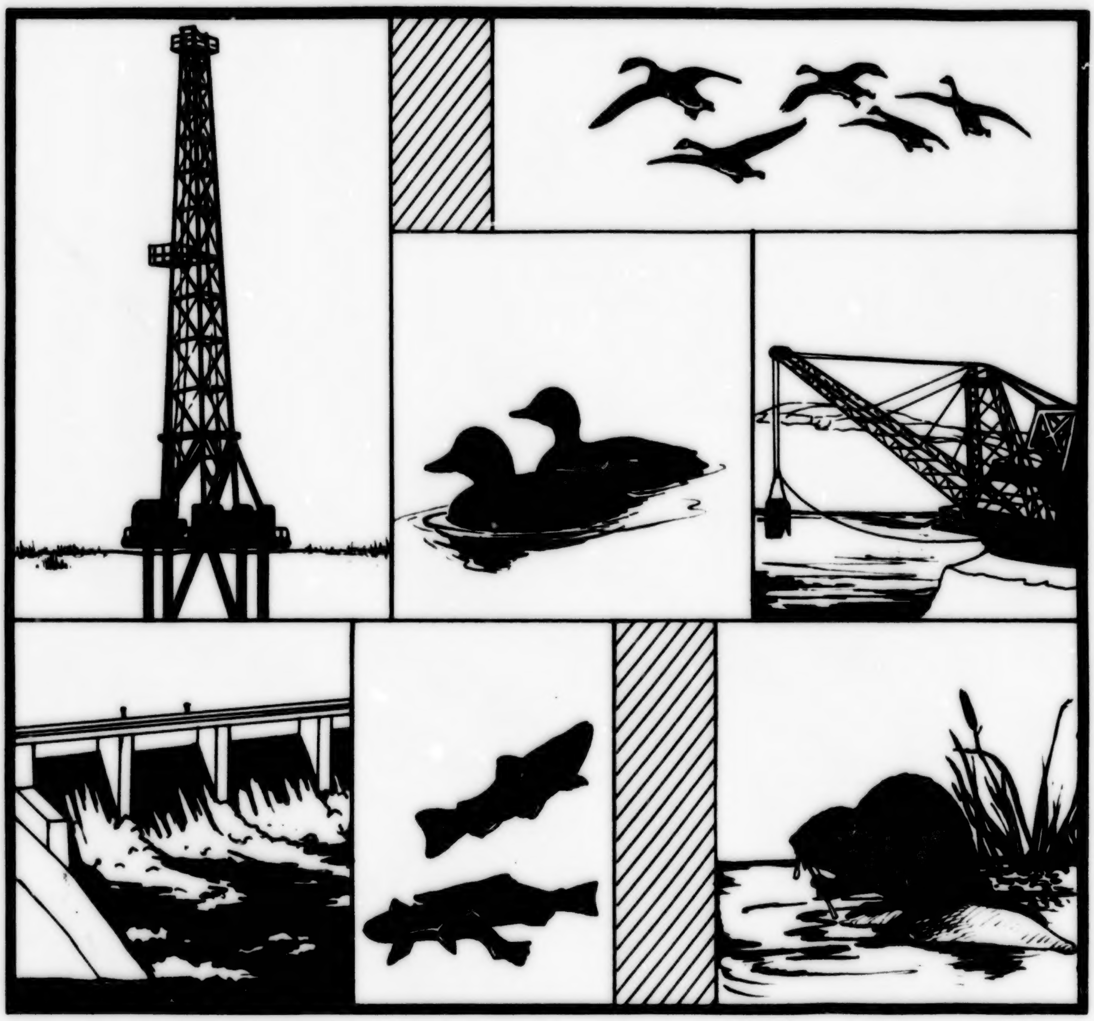
MAINTENANCE OF FLOWS DOWNSTREAM FROM WATER DEVELOPMENT PROJECTS IN COLORADO, MONTANA, AND WYOMING

Appendix A



Fish and Wildlife Service

U.S. Department of the Interior

Biological Report 88(27) Appendix A
August 1988

MAINTENANCE OF FLOWS DOWNSTREAM FROM WATER DEVELOPMENT PROJECTS IN COLORADO, MONTANA, AND WYOMING

APPENDIX A

by

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INTRODUCTION

PURPOSE

Detailed information on the water development projects evaluated in this study is presented. The information is organized into a "fact sheet" for each project, which details the location, function, completion date, operators, minimum streamflow agreement, streamflow releases, objective, information and methods used, recommendations, and streamflow records. The agencies, personal communications, and references used in developing each fact sheet are cited. These fact sheets were developed to document the information from which our summary data were derived. Hopefully, they will provide other workers with baseline information useful in future assessments of water development projects.

The following abbreviations are used on the fact sheets to designate Federal and State agencies and common statutes.

FERC - Federal Energy Regulatory Commission

FWS - U.S. Fish and Wildlife Service

BR - U.S. Bureau of Reclamation

BLM - U.S. Bureau of Land Management

COE - U.S. Army Corps of Engineers

FS - U.S. Forest Service

SCS - U.S. Soil Conservation Service

WGFD - Wyoming Game and Fish Department

MDFWP - Montana Department of Fish, Wildlife and Parks

CDWR - Colorado Division of Wildlife Resources

NPPC - Northwest Power Planning Council

FWCA - Fish and Wildlife Coordination Act

NEPA - National Environmental Policy Act

ORGANIZATION OF FACT SHEETS

The following information is provided for each fact sheet.

Location

Location is described relative to the stream, drainage basin, county, and State of the water development project.

Function

Function indicates the primary purpose(s) for which the water development project was constructed.

Completion Date

Completion date is the year in which the water development project began to function.

Operators

Operators designates the private organization, corporation, utility, or State or Federal agency that operated the project upon its completion.

Minimum Streamflow Agreement

This category describes the licenses, permits, or other documents that contain the minimum streamflow agreement.

Streamflow Releases

This section provides a narrative summary of the history of streamflows downstream from the project based on our information.

Objective

The objective is the reason for which the minimum streamflow releases were negotiated. It identifies the resources being protected or enhanced by the agreement.

Information and Methods Used

The kinds of information and methods applied to assess instream flow needs are presented based on the information we could obtain.

Recommendations

The U.S. Fish and Wildlife Service recommendations regarding instream flows are summarized in this section. The summary is based on minimal information for several projects.

Streamflow Records

The periods of record at specific gaging stations from which our summaries of streamflow data were developed are indicated. This section includes the source of the data, years of available records, and the frequency of streamflow discrepancies. See Table 1 in the main report for definitions of discrepancies.

Other

Records of the agencies, personal communications, and references from which the fact sheet was developed are listed to provide future workers with access to these sources.

FACT SHEETS FOR COLORADO

Yamcolo Reservoir
Green River Basin

Location	Storage dam and reservoir are located on the Bear River (Yampa River), Routt National Forest, near Yampa, Colorado.
Function	Primarily municipal and industrial water supply
Completion Date	Early 1980's
Operators	Upper Yampa Water Conservancy District
Minimum Streamflow Agreement	A FS permit was issued in 1979 to the Upper Yampa Water Conservancy District for the construction of Yamcolo Reservoir. Another FS special use permit was issued in 1982 for the maintenance and operation of the reservoir. This permit incorporated the COE 404 permit issued to the operators in 1978 (revised in 1981 and 1982), which established a minimum streamflow release from the reservoir.
Streamflow Releases	The original minimum streamflow specified in the COE and FS permits prior to 1982 was a 12-cfs release from the reservoir at all times during construction and operation. In 1982, the minimum streamflow requirement was modified to a 5-cfs minimum flow to be maintained in the Bear River to the confluence of Coal Creek October 1 through May 1, and a 12-cfs minimum flow the remainder of the year.
Objective	To maintain the downstream aquatic habitat. In the 1979 Environmental Assessment prepared by the FS, it was stated that the downstream fisheries were expected to improve with a minimum flow of 12 cfs.
Information and Methods Used	In the fall of 1976, CDWR biologists conducted a stream survey and applied the R-2 Cross method to measurements taken on the Bear River below the reservoir site.
Recommendations	In 1977, the CDWR stated that a minimum flow of 12 cfs would meet their fishery criteria. The FWS also recommended a minimum flow of 12 cfs in a 1978 letter to the COE. In 1981, the operators requested that the minimum flow be changed to 5 cfs in order to provide additional water storage. The CDWR evaluated the request and approved the reduced minimum flows, but only during the winter months. Apparently the FWS concurred with the CDWR. In 1982, the COE modified the minimum flow stipulations to reduce the amount of streamflow release to 5 cfs October 1 through May 1. The FS special use permit automatically incorporates any revisions to the COE 404 permit.
Streamflow Records	No streamflow records were available from USGS or the State Engineers Office.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

U.S. Forest Service, Routt National Forest, Yampa Ranger District, Yampa, Colorado.

Personal Communications

Garrison, B. U.S. Fish and Wildlife Service, Salt Lake City, Utah. June 1987.

Jaminet, J. U.S. Forest Service, Routt National Forest, Yampa Ranger District, Yampa, Colorado. 1987.

References

Colorado Division of Wildlife. [Letter to Western Engineer, Inc., Grand Junction, Colorado]. 1977 March 8.

Environmental Protection Agency. [Letter to District Engineer, Corps of Engineers, Sacramento, California]. 1982 January 4.

U.S. Army Corps of Engineers. [Letter to Upper Yampa Water Conservancy District, Steamboat Village, Colorado]. 1982 February 17.

U.S. Fish and Wildlife Service. [Letter to Corps of Engineers, Sacramento, California]. 1978 August 30.

U.S. Forest Service. 1979. Environmental Assessment, Yamcolo Reservoir. U.S. Department of Agriculture, Forest Service, Routt National Forest.

Allen Basin Reservoir Ditch Enlargement
Green River Basin

Location	Diversion dams are located on South Hunt, Mill, and Bull Creeks, Routt National Forest, Rio Blanco and Routt Counties, Colorado.
Function	Dams divert water from South Hunt, Mill, and Bull Creeks into Allen Basin Reservoir on the Hunt River. Water is used as an irrigation supply.
Completion Date	The diversion dams and conveyance canal were completed in 1966, except for the conveyance ditch from South Hunt Creek, which was not completed until after 1968.
Operators	Allen Basin Reservoir Company
Minimum Streamflow Agreement	In 1964, a FS special use permit was issued to the Allen Basin Reservoir Company for the construction and maintenance of diversion dams and ditches to provide additional water for irrigation by diverting excess spring flows from South Hunt, Mill, and Bull Creeks. Condition 35 of the FS permit specifies minimum instantaneous flows below each of the three diversions.
Streamflow Releases	Minimum instantaneous flows of 0.5 cfs or the natural flow, whichever is less, are required below the diversion dams in Mill and Bull Creeks, and 1 cfs or the natural flow, whichever is less, is required below the diversion dam in South Hunt Creek.
Objective	To preserve the fishery in the above three streams.
Information and Methods Used	The minimum streamflows were determined from a joint field review of the proposed diversion sites and streams conducted by representatives from the FWS, FS, and Colorado Department of Game, Fish and Parks (now CDWR) in the fall of 1964.
Recommendations	The FWS, in January of 1965, with concurrence from the Colorado Department of Game, Fish and Parks, recommended minimum streamflows below the three diversion dams identical to the requirements incorporated into the FS special use permit. Even though the permit

was issued prior to the FWS official recommendations, the FS issued the permit after the joint field review had been conducted.

Streamflow Records	None

Agency Files Providing Project Information

U.S. Forest Service, Yampa Ranger District, Routt National Forest, Yampa, Colorado.

References

Colorado Department of Game, Fish and Parks. [Letter to Director, U.S. Fish and Wildlife Service]. 1965 January.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Fish and Wildlife Service. [Letter to Regional Forester, U.S. Forest Service, Denver, Colorado]. 1965 January 26.

Taylor Draw Reservoir Project
Green River Basin

Location	Storage dam and reservoir are located on the White River near Rangely in Rio Blanco County, Colorado.
Function	To provide a dependable source of water for municipal and industrial use by the city of Rangely. Other uses include flood control, agriculture, and recreation.
Completion Date	1984
Operators	Colorado River Water Conservation District
Minimum Streamflow Agreement	The FWS's Biological Opinion recommended a minimum streamflow release from Taylor Draw Dam. The Biological Opinion was subsequently made a part of a Memorandum of Agreement between the Conservation District, CDWR, and the FWS. The COE 404 permit issued for the project in 1982 incorporated the Memorandum of Agreement; consequently, the minimum flow release is a condition of the 404 permit.
Streamflow Releases	The majority of the time, Taylor Draw will be operated as a run-of-river reservoir. However, during drought years, when it is necessary to retain storage water, a minimum flow of 200 cfs or the natural flow, whichever is less, will be released from the reservoir.
Objective	To provide adequate flows for all life stages of the Colorado squawfish (*Ptychocheilus lucius*).
Information and Methods Used	The CDWR began studies on the White River in the late 1970's in response to the BR's proposed Yellow Jacket Project. The CDWR applied the R-2 Cross method and IFG4 to determine minimum streamflows. A minimum flow of 250 cfs was determined for the lower reach of the White River down to the Colorado-Utah border. The CDWR filed for an instream flow on this reach and the Colorado Conservation Board changed the amount from 250 to 200 cfs. Due to ensuing controversies, the instream flow filing was eventually

dropped. When the Taylor Draw Reservoir Project came along, minimum streamflow recommendations were apparently based on the 200 cfs that had been filed for. In addition, the FWS reviewed historic streamflow records and began biological investigations on the Colorado squawfish.

Recommendations

The FWS recommended a minimum streamflow release of 200 cfs during drought years from Taylor Draw Reservoir. The recommendation was made in the FWS's Biological Opinion dated May 20, 1982.

Streamflow Records

There is a USGS gage located upstream from the project, but there are no downstream flow records. According to representatives from CDWR and the Colorado River Water Conservation District, there have been no problems maintaining adequate streamflows in the White River below the dam.

Agency Files Providing Project Information

U.S. Army Corps of Engineers, Regulatory Office, Grand Junction, Colorado.

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

Personal Communications

Burkhart, W. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

Merritt, D. Northern Colorado River Conservation District, Glenwood Springs, Colorado. May 1987.

References

U.S. Fish and Wildlife Service, Denver, Colorado. [Letter to U.S. Army Corps of Engineers, Sacramento, California, FWS Biological Opinion]. 1982 May 20.

Colorado-Big Thompson Project
Colorado and Lower Missouri River Basins

General Description

The Colorado-Big Thompson Project was authorized by the Act of August 9, 1937 (50 Stat. 595), and is one of the largest projects constructed by the BR. There are over 100 structures involved in storing water from the Colorado River on the west slope of the Rocky Mountains and diverting water across the Continental Divide to the eastern slope for irrigation, power generation, municipal, and other uses. The BR is responsible for operating all project facilities.

Four features of the Colorado-Big Thompson have minimum streamflow provisions and are described herein: Granby Dam and Lake, Willow Creek Dam and Reservoir, and Shadow Mountain Dam and Reservoir, all located on the Colorado River, and Olympus Dam and Lake Estes located on the Big Thompson River.

Shadow Mountain Dam and Reservoir
Colorado River Basin

Location

Storage dam and reservoir are located on the Colorado River, upstream from both Granby and Willow Creek Dams, near Grand Lake in Grand County, Colorado.

Function	The reservoir stores water from the North Fork of the Colorado River and water pumped from Lake Granby. Water from Shadow Mountain Reservoir flows into Grand Lake at the northeastern end of the reservoir and subsequently is released into the Alva B. Tunnel, which conveys water across the Continental Divide to the eastern slope primarily for irrigation and power generation.
Completion Date	Construction on the dam began in 1944 and was completed in 1946. Operations began in 1949 when other features of the Colorado-Big Thompson Project were completed.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	The BR adopted minimum flow releases from Shadow Mountain Reservoir around 1947. The minimum streamflow releases have been incorporated into the BR's operating criteria.
Streamflow Releases	The minimum flow releases from Shadow Mountain Reservoir into the Colorado River are 25 cfs October 1 through May 31, and 50 cfs June 1 through September 30. Recently, the BR has modified the flow regime by request from the CDWR to facilitate kokanee spawning. The modified flow regime is 20 cfs January through May, 50 cfs June through July, 40 cfs in August, 35 cfs September through October, and 45 cfs November through December, or the natural inflow, whichever is less.
Objective	To maintain the downstream fishery and aquatic habitat, and more recently to facilitate kokanee spawning.
Information and Methods Used	The original flow regime, followed until just recently (1986), was based on changes in aquatic habitat conditions from 50 to 100 cfs. The aquatic habitat studies were conducted by the FWS in the late 1940's.
Recommendations	The FWS recommended the original flow releases in 1947. The BR accepted the flow release schedule with the added condition that if the inflow was less than the minimum flow amount, the outflow would equal the inflow.
Streamflow Records	There are no streamflow records for the Colorado River immediately below Shadow Mountain Dam.

Granby Dam and Lake Granby
Colorado River Basin

Location	Storage dam and reservoir are located on the Colorado River less than five miles downstream from Shadow Mountain Dam, near Granby in Grand County, Colorado.
Function	Lake Granby is the primary storage facility on the west slope. Water from the Colorado River is stored in Lake Granby and then pumped into Shadow Mountain Lake. Water from Lake Granby is primarily used for irrigation and power generation on the eastern slope.
Completion Date	Water was initially stored in the fall of 1949, but the dam was not completed until 1950. The Granby Pump, used to pump water into Shadow Mountain, was also completed in 1950.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	An interim minimum flow release schedule was proposed by the BR and accepted by the Secretary of the Interior in 1951. The minimum flow schedule was permanently adopted in 1961, and subsequently incorporated into the BR's operating criteria for the Colorado-Big Thompson Project.

Streamflow Releases

The minimum flow release schedule from Lake Granby is 20 cfs October through April (to be measured below the dam), and 75 cfs May through July, 40 cfs during August, and 20 cfs during September (measured at a point about 3 miles downstream from Granby Dam).

If forecasts indicate that inflows for the water year will be below normal (less than 230,000 acre-feet), minimum releases can be reduced during the period of May through September according to the following schedule:

Forecast inflow in acre-feet	Percent reduction in minimum flow release
220,000 - 230,000	15
210,000 - 220,000	20
195,000 - 210,000	25
Less than 195,000	30

Objective

To maintain the downstream trout fishery.

Information and Methods Used

The FWS, with cooperation from the CDWR, conducted aquatic habitat studies between 1947 and 1951. Stream sections were examined to determine changes in aquatic habitat (riffles, pools, exposed stream bottom, etc.) under different river flow conditions. Fisherman-use and fishery harvest were also estimated from surveys. In addition, historical streamflow records for the Colorado River near Granby were examined.

Recommendations

In 1951, the FWS recommended an extensive and complicated flow release schedule for Lake Granby. The release schedule was acquired from a study by Nelson et al. (1976) as we could not locate a copy in FWS files. The recommended releases (in cfs) were:

Oct 1 - 30	85	Mar 30	45
Oct 31 - Nov 13	75	Mar 31 - Apr 6	50
Nov 14	70	Apr 7	55
Nov 15	65	Apr 8	60
Nov 16 - 29	60	Apr 9 - 19	65
Nov 30	55	Apr 20	70
Dec 1 - 15	50	Apr 21	75
Dec 16 - 30	45	Apr 22 - 28	80
Dec 31	42	Apr 29	85
Jan 1 - 13	40	Apr 30 - May 13	90
Feb 1	38	May 14	95
Feb 2 - Mar 1	35	May 15 - Aug 30	100
Mar 2	37	Aug 31	95
Mar 3 - 29	40	Sep 1 - Sep 14	90
		Sep 15 - 30	85

The FWS recommended that the above flows be maintained in the Colorado River from Granby Dam four miles down to the confluence of Willow Creek.

Streamflow Records

There is approximately a four-mile reach of the Colorado River from Granby Dam to the confluence with Willow Creek. We evaluated streamflow records from two USGS gages located along this reach. The first gage is located 0.3 miles below Granby Dam and was used to evaluate releases of 20 cfs from October through April (records were available through water year 1982). The second gage is located on the Colorado River 1.3 miles upstream from the confluence with Willow Creek (almost 3 miles below the dam). Records from this station (1950 through 1985) were used to evaluate releases from Lake Granby the remainder of the year.

Percent of record showing streamflow discrepancies: 53.2
Percent of record showing streamflow discrepancies greater than 10 percent: 17.8
Percent of record showing streamflow discrepancies greater than 25 percent: 6.9
Percent of record showing streamflow discrepancies greater than 50 percent: 1.1

Percent of record showing streamflow discrepancies greater than 75 percent: 0.1

There are no upstream records; thus, we were not able to evaluate how often inflows to the project were below the accepted minimum releases. In addition, we did not have information that would allow an evaluation of releases according to the different inflow forecasts. According to the BR, low flows below Granby Lake are due most often to low inflow conditions. Operational and maintenance problems and power outages have also reduced flow releases, but these are isolated situations and generally only a few hours in duration.

Willow Creek Dam and Reservoir
Colorado River Basin

Location	Storage dam and reservoir are located on Willow Creek about four miles upstream from the confluence with the Colorado River, Grand County, Colorado. Willow Creek flows into the Colorado River about four miles downstream from Granby Dam.
Function	Willow Creek Dam diverts water from Willow Creek into Lake Granby where it is pumped into Shadow Mountain Reservoir and eventually transported to the east slope, primarily for irrigation and power generation.
Completion Date	Willow Creek Dam was completed in 1953 and initial water storage took place that same year. The Willow Creek Feeder Canal, which carries water from the reservoir to the Willow Creek Pumping Plant and then into Lake Granby, was completed in 1953.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	Initially, the BR provided a 7-cfs year-round minimum release from Willow Creek Reservoir. However, in 1961 a nonirrigation season release of 7 cfs was adopted by the Secretary of the Interior and releases during the remainder of the year depended on downstream irrigation demands. The nonirrigation minimum flow release was subsequently incorporated into the BR's operating criteria.
Streamflow Releases	According to the BR's operating criteria, Willow Creek is not considered a valuable fishery since irrigation diversions below the dam severely reduce streamflows. However, a minimum release of 7 cfs or the inflow, whichever is less, is required from October 1 through April 30 to augment fishery flows in the Colorado River.
Objective	To augment fishery flows in the Colorado River below the confluence with Willow Creek.
Information and Methods Used	Stream studies were not conducted on Willow Creek. The FWS and CDWR, when reviewing the proposed project, based their recommendations for Willow Creek Reservoir and Dam on historic streamflow information and streamflow requirements for the Colorado River.
Recommendations	The FWS, with cooperation from the CDWR, recommended minimum streamflow releases from Willow Creek Reservoir in 1951. The following recommended release schedule was acquired from a study by Nelson et al. (1976), as the 1951 FWS report could not be located in FWS files.

Oct 1 - 15	15 cfs
Oct 16 - Nov 10	10 cfs
Nov 11 - Mar 29	7 cfs
Mar 30	10 cfs
Mar 31 - Apr 15	15 cfs
Apr 16 - 29	20 cfs

The BR did not accept the above release schedule, and a release of 7 cfs, or the inflow, was instituted. According to Nelson et al. (1976), the fact that the 1937 Authorizing Act for the Colorado-Big Thompson Project included preservation of the fishery in the Colorado River, but not in its tributaries, may have prevented the above recommendations from being accepted.

Streamflow Records

Downstream Station: USGS
Period of record evaluated: 1954-1982

Percent of record showing streamflow discrepancies: 42.4
Percent of record showing streamflow discrepancies greater than 10 percent: 9.3
Percent of record showing streamflow discrepancies greater than 25 percent: 1.8
Percent of record showing streamflow discrepancies greater than 50 percent: 0.6
Percent of record showing streamflow discrepancies greater than 75 percent: 0.5

Upstream and downstream stations: USGS
Period of record evaluated: 1954-1960

Percent of downstream flow record showing streamflow discrepancies when inflows were at least 7 cfs on the same day: 33.6
Percent of record showing streamflow discrepancies greater than 10 percent: 8.0
Percent of record showing streamflow discrepancies greater than 25 percent: 0.7
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

Upstream flow records were only available for the years of 1954 through 1960. During this period mean daily flows below the reservoir were less than 7 cfs almost 34 percent of the time when inflows were at least 7 cfs. Low inflows did not appear to be related to streamflow discrepancies greater than 10 or 25 percent either. We were not able to determine what factors may be related to low flows below Willow Creek Reservoir.

Olympus Dam and Lake Estes
Lower Missouri River Basin

Location

Storage dam and reservoir are located on the Big Thompson River, near Estes Park in Larimer County, Colorado.

Function

Olympus Dam stores water from the Big Thompson River, controls releases from the Estes Powerplant located upstream, and releases water to downstream power generating facilities. The project also supplies water for irrigation.

Completion Date

Construction began on Olympus Dam in 1947 and was completed in 1949. Water was initially stored in 1948.

Operators

Bureau of Reclamation

Minimum Streamflow Agreement

Minimum streamflows recommended by the FWS and CDWR were accepted by the BR in 1950 and subsequently incorporated into the operating criteria.

Streamflow Releases

The following flow amounts (in cfs) or the inflow, whichever is less, are released from Estes Lake.

November 1 - April 15	25
April 16 - 30	50
May 1 - 15	100
May 16 - August 15	125
August 16 - 31	100
September 1 - 15	75
September 16 - October 31	50

Objective

To preserve the trout fishery and aquatic habitat in the Big Thompson River below Olympus Dam.

Information and Methods Used

In 1950, after the dam was completed, the FWS and CDWR conducted summer and fall aquatic habitat studies. Transects across the river channel were used to examine various aquatic habitat conditions (pools, riffles, exposed stream bottom, etc.) in relation to different flow releases.

Recommendations

Following the 1950 aquatic studies, the FWS and CDWR recommended the minimum flow release schedule indicated above. The BR accepted the schedule with the understanding that releases in excess of the inflow to Lake Estes would not be required.

Streamflow Records

Downstream Station: USGS
Period of record evaluated: 1950-1985

Percent of record showing streamflow discrepancies: 64.5
Percent of record showing streamflow discrepancies greater than 10 percent: 57.4
Percent of record showing streamflow discrepancies greater than 25 percent: 40.0
Percent of record showing streamflow discrepancies greater than 50 percent: 17.1
Percent of record showing streamflow discrepancies greater than 75 percent: 4.2

Upstream and downstream stations: USGS
Period of record evaluated: 1950-1985

Percent of downstream record showing streamflow discrepancies when inflows were sufficient to release the accepted minimum amount on the same day: 14.8
Percent of record showing streamflow discrepancies greater than 10 percent: 11.1
Percent of record showing streamflow discrepancies greater than 25 percent: 3.0
Percent of record showing streamflow discrepancies greater than 50 percent: 1.4
Percent of record showing streamflow discrepancies greater than 75 percent: 0.6

Evaluation of upstream flow records revealed that low upstream flows corresponded to 77 percent of the days when releases from Lake Estes were below the recommended minimum flow amount. Thus, the minimum flow amounts, or inflow, were maintained about 85 percent of the time since 1950.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Lakewood, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Personal Communications

Haegle, M. U.S. Bureau of Reclamation, Environmental Section, Loveland Projects Office, Colorado. March 1987.

Price, G. U.S. Bureau of Reclamation, Water and Land Group, Loveland Projects Office, Colorado. March 1987.

Sealing, C. Colorado Division of Wildlife Resources, Grand Junction, Colorado. January 1988.

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Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Bureau of Reclamation. 1957. Colorado-Big Thompson Project, Volume I. U.S. Department of Interior, Bureau of Reclamation, Denver, Colorado.

U.S. Bureau of Reclamation. 1982. Colorado-Big Thompson Project. U.S. Government Printing Office.

U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation. 1955. Joint report on fishery flows below Granby and Willow Creek Dams, Colorado-Big Thompson Project. U.S. Department of Interior, Fish and Wildlife Service and Bureau of Reclamation.

Fraser River Diversion System
Colorado River Basin

Location Diversion dams are located on the Fraser River, Vasquez, St. Louis, and Ranch Creeks, Grand County, Colorado.

Function The diversion system collects water from the Fraser River and tributaries into the Moffat Tunnel. The tunnel conveys water over the Continental Divide into South Boulder Creek and Gross Reservoir to supply municipal water for the Denver area.

Completion Date The original project features were completed in 1936. Since that time there have been various extensions, enlargements, and improvements. Vasquez diversion dam was enlarged in 1965.

Operators Denver Water Board

Minimum Streamflow Agreement The original project features began operation in 1936 under a BLM permit. In 1958, the Denver Water Board began plans for enlarging the Vasquez diversion dam. Apparently the reconstruction was done under a FS permit, and in 1970 the BLM issued a final permit that covered all the diversions and established minimum streamflows.

Streamflow Releases The following minimum bypass flows or the natural streamflow, whichever is less, are required by the 1970 BLM permit:

Diversion Dam	May 15 - September 15	September 16 - May 14
Fraser River	10 cfs	4 cfs
Vasquez Creek	8 cfs	3 cfs
St. Louis Creek	10 cfs	3 cfs
Ranch Creek	4 cfs	2 cfs

Minimum bypass flows are subject to modification when storage in Gross Reservoir is less than 25,000 acre-feet, and if bypass flows from September 16 through May 14 are determined (by the Denver Water Board) to impair the operation of the water works system they can be reduced or discontinued. The minimum bypass flows can also be reduced if the Denver Water Board determines it is necessary to impose water restrictions due to short water supply.

Objective To provide a reasonable degree of protection for fish habitat in the Fraser River and its tributaries.

Information and Methods Used The minimum bypass flows were based on historical streamflow records, professional judgment, and negotiations. Agencies involved in determining minimum flows were the FWS, Colorado Department of Game, Fish and Parks (now CDWR), BLM, FS, and Denver Water Board.

Recommendations

The FWS first recommended minimum flows below the diversion dams in 1960. This was in response to the enlargement of Vasquez diversion dam and construction of the Vasquez Tunnel, which transports water from the Williams Fork River system into the Fraser River system. The FWS recommended the following minimum bypass flows or the natural streamflow, whichever was less:

Diversion Dam	May 15 - September 15	September 16 - May 14
Fraser River	8 cfs	4 cfs
Vasquez Creek	8 cfs	3 cfs
St. Louis Creek	9 cfs	3 cfs
Ranch Creek	4 cfs	none

It was not until 1969 that the Denver Water Board agreed to the releases, with slight modifications. The most significant modifications were the conditions that allowed the Board to reduce the bypass flows.

Streamflow Records

Station: USGS gage located on the Fraser River
Period of record evaluated: 1971-1986

Percent of record showing streamflow discrepancies: 13.2
Percent of record showing streamflow discrepancies greater than 10 percent: 8.1
Percent of record showing streamflow discrepancies greater than 25 percent: 2.9
Percent of record showing streamflow discrepancies greater than 50 percent: 1.0
Percent of record showing streamflow discrepancies greater than 75 percent: 0.1

Station: USGS gage located on Vasquez Creek
Period of record evaluated: 1971-1986

Percent of record showing streamflow discrepancies: 23.7
Percent of record showing streamflow discrepancies greater than 10 percent: 18.6
Percent of record showing streamflow discrepancies greater than 25 percent: 11.5
Percent of record showing streamflow discrepancies greater than 50 percent: 0.4
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Station: USGS gage located on St. Louis Creek
Period of record evaluated: 1971-1986

Percent of record showing streamflow discrepancies: 0.5
Percent of record showing streamflow discrepancies greater than 10 percent: 0.2
Percent of record showing streamflow discrepancies greater than 25 percent: 0.02
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

Station: USGS gage located on Ranch Creek
Period of record evaluated: 1971-1986

Percent of record showing streamflow discrepancies: 12.4
Percent of record showing streamflow discrepancies greater than 10 percent: 6.0
Percent of record showing streamflow discrepancies greater than 25 percent: 1.8
Percent of record showing streamflow discrepancies greater than 50 percent: 0.2
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Due to the language of the agreement, conditions that allow the Denver Water Board to reduce the minimum bypass flows, and lack of upstream flow data, it is difficult to identify specific factors that are contributing to the low flows. The FWS has inspected the project on several occasions and has expressed, to the Denver Water Board, how difficult it is to interpret some of the conditions in the permit and thus monitor the project. Representatives with the CDWR have realized that low natural flows in the Fraser River system may contribute to the problem at times.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Denver, Colorado.

Personal Communications

Burkhart, W. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

References

Denver Water Department. 1976. Features of the Denver Water System. Office of Public Affairs, Denver Water Department, Denver, Colorado.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Bureau of Land Management, Colorado Land Office, Denver, Colorado. [Letter to Denver Water Board concerning final minimum streamflow decision]. 1970 April 22.

U.S. Fish and Wildlife Service, Albuquerque, New Mexico. [Letter to State Director, Bureau of Land Management, Denver, Colorado]. 1969 November 21.

U.S. Fish and Wildlife Service, Field Office, Denver, Colorado. [Memorandum to Regional Director, Fish and Wildlife Service, Albuquerque, New Mexico]. 1971 January 28.

U.S. Fish and Wildlife Service, Field Office, Denver, Colorado. [Memorandum to Regional Director, U.S. Fish and Wildlife Service]. 1971 February 16.

Cabin Meadows Transmountain Diversion Project
Colorado River Basin

Location	This project involves water diversions from five small streams, and a small reservoir located on the Arapaho National Forest, Sulphur Ranger District, Colorado. Meadow Creek Reservoir is located on Meadow Creek, and the other diversions involve Hamilton, Hurd, Trail, Little Cabin, and Cabin Creeks.
Function	Water is diverted from the west side of the Continental Divide and transported to the east side for municipal use by the City of Englewood.
Completion Date	Diversion structures were completed in February of 1975.
Operators	The City of Englewood operates the project, but the Denver Water Board also diverts water from the same stream system and apparently does some of the maintenance.
Minimum Streamflow Agreement	A BLM right-of-way permit was issued in April of 1974 and established minimum streamflow requirements. The project is located on FS land, but we were not able to ascertain why a BLM right-of-way rather than a FS permit was issued.
Streamflow Releases	Stipulation 23 of the right-of-way sets forth the following minimum streamflows or the inflow, whichever is less:

Little Cabin Creek	0.25 cfs
Cabin Creek	2.0 cfs
Hamilton Creek	1.0 cfs May 1 - June 14, and 1.5 cfs June 15 - April 30
Hurd Creek	1.0 cfs
Meadow Creek	3.0 cfs May 1 - March 31, and 1.5 cfs April 1 - April 30

Stipulation 25 of the permit states that the permittee will furnish copies of water storage, releases, and streamflow summary records to the FS District Ranger.

Objective

To protect the aquatic ecosystem and other National Forest values.

Information and Methods Used

No stream surveys were conducted to determine the minimum streamflows. According to FWS representatives, the minimum flows were based on the size of the watershed and available streamflow data. There are no USGS gages on any of the streams near the diversion sites.

Recommendations

The Sulphur Ranger District, Arapaho National Forest, had on file a 1972 letter from the FWS that recommended the above minimum streamflows. We were not able to locate any information on this project in FWS files in Colorado.

Streamflow Records

None. The Sulphur Ranger District has received streamflow summaries concerning flows below the diversion structures. Apparently the Denver Water Board supplies this information. According to the personnel at Sulphur Ranger District, there have been some occasions when the streamflows appeared to be lower than the minimum flow requirement and the operators were contacted to correct the situation. The FS does not physically measure the streamflows or routinely check the system. The system is visually checked when FS and CDWR personnel are working in the vicinity.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

Personal Communications

Bailey, J. U.S. Forest Service, Arapaho National Forest, Sulphur Ranger District, Hot Sulphur Springs, Colorado. June 1987.

Helbig, V. Retired, U.S. Fish and Wildlife Service, Denver, Colorado. October 1987.

Taylor, B. Denver Water Board, Denver, Colorado. July 1987.

Williams Fork Dam and Reservoir
Colorado River Basin

Location

Storage dam and reservoir are located on the Williams Fork River near Parshall in Grand County, Colorado.

Function

Water stored in Williams Fork Reservoir is used to replace water diverted from the Colorado River system elsewhere for municipal use on the east slope of the Rocky Mountains. Water from the Williams Fork is transported through the Jones Pass Tunnel into the Vasquez Tunnel and released into Vasquez Creek to replace water diverted by the Fraser River Collection System. Releases from Williams Fork Reservoir are also used to generate power at a powerplant located at the dam.

Completion Date	The original dam was constructed in 1938. The Denver Water Board enlarged the dam and reservoir to provide exchange water in 1959.
Operators	Denver Water Board (DWB)
Minimum Streamflow Agreement	The BLM issued a right-of-way to the City and County of Denver on September 25, 1956, which included minimum streamflow stipulations recommended by the Bureau of Sport Fisheries and Wildlife (now the FWS). The City and County of Denver appealed the decision and in 1958 the Director of the BLM upheld the decision with some modifications. Several more appeals ensued and on July 15, 1964 a final decision was reached and the BLM 1956 right-of-way was amended to include the modified minimum streamflow requirements. A FERC license was issued to the City and County of Denver on January 31, 1963. The license was amended on March 17, 1966 to include Articles 32 through 34, which restated the minimum streamflows required by the BLM right-of-way.
Streamflow Releases	The minimum streamflow release from Williams Fork Reservoir is 15 cfs or the inflow, whichever is less, at all times except during emergencies or temporary periods of maintenance and repair work. During the irrigation season, 15 cfs in addition to water being released for downstream irrigation rights should be released. The right-of-way contains some additional conditions allowing the DWB to reduce the minimum flow during the irrigation season.
Objective	To protect the downstream fishery, and to replace loss of or damage to the fishery resources.
Information and Methods Used	The minimum streamflow amount was based on historic streamflow records, professional observations, operational information for Williams Fork Reservoir, and negotiations.
Recommendations	Originally, the FWS (with agreement from the CDWR) recommended a minimum flow release of 35 cfs, or the inflow, from Williams Fork Reservoir. This was included in the original BLM right-of-way that was appealed by the DWB. The amount recommended by the FWS was eventually reduced to 15 cfs and included in BLM's final decision.
Streamflow Records	Station: USGS gage located below Williams Fork Dam Period of record evaluated: 1964-1986 Percent of record showing streamflow discrepancies: 6.2 Percent of record showing streamflow discrepancies greater than 10 percent: 2.2 Percent of record showing streamflow discrepancies greater than 25 percent: 0.1 Percent of record showing streamflow discrepancies greater than 50 percent: 0.1 Percent of record showing streamflow discrepancies greater than 75 percent: 0.0 Upstream flow records indicate that inflow was below 15 cfs on only 4 percent of the occasions when releases from Williams Fork Reservoir were below 15 cfs; this changes the percent of time flows were maintained by less than one-half percent.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

Federal Energy Regulatory Commission, San Francisco, California.

Federal Energy Regulatory Commission, Washington, D.C.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Lakewood, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Personal Communications

Taylor, B. Denver Water Board, Environmental Section, Denver, Colorado. July 1987.

References

Denver Water Department. 1976. Features of the Denver Water System. Office of Public Affairs, Denver Water Department, Denver, Colorado.

Federal Power Commission. 1963. Order issuing license (major) to City and County of Denver, Project No. 2204, January 31, 1963. U.S. Federal Power Commission.

Federal Power Commission. 1966. Presiding examiner's initial decision on application for amendment of the license. U.S. Federal Power Commission, license issued March 17, 1966 to City and County of Denver, Project No. 2204.

U.S. Fish and Wildlife Service. 1960. Fish and wildlife resources of the Williams Fork Project, Bureau of Land Management right-of-way application No. 050054, Colorado. U.S. Department of Interior, Fish and Wildlife Service, Branch of River Basin Studies, Albuquerque, New Mexico.

Windy Gap Project
Colorado River Basin

Location	Diversion dam is located on the Colorado River at Windy Gap near Granby in Grand County, Colorado.
Function	Water is diverted from the Colorado River, transported through a conduit to Granby Reservoir, and then transported over the Continental Divide into the Big Thompson River. Project water is used for cooling operations in a power generating facility, and for municipal purposes on the east slope of the Rocky Mountains.
Completion Date	1985
Operators	Northern Colorado Conservancy District (NCCD)
Minimum Streamflow Agreement	On June 23, 1980, the NCCD entered into a Memorandum of Understanding with the CDWR to maintain minimum streamflows in the Colorado River from below the Windy Gap Diversion down to the mouth of the Blue River.
Streamflow Releases	The NCCD agreed to maintain the following fixed rates of flow: 90 cfs from Windy Gap Diversion Point to the mouth of the Williams Fork River, 135 cfs from the mouth of the Williams Fork to the mouth of Troublesome Creek, and 150 cfs from the mouth of Troublesome Creek to the mouth of the Blue River. In addition, if necessary flushing flows do not occur, every three years the NCCD will release a total of 450 cfs for fifty hours sometime during the period of April 1 through June 30.
Objective	To maintain the wild rainbow trout fishery in the Colorado River between the mouth of the Williams Fork River and the mouth of Troublesome Creek. The FWS, in its Biological Opinion, addressed maintaining base flows for endangered fish species (Colorado squawfish and humpback chub) farther downstream in the Colorado River.

Information and Methods Used

Initial cross section measurements (depth, width, wetted perimeter, and velocity) were collected by the CDWR in 1977. In July of 1978, a joint field inspection was conducted by the FWS, CDWR, BR, and BLM using the information that had been collected by the CDWR the previous year. The CDWR conducted studies on the Colorado River between Williams Fork River and Troublesome Creek in 1979 and 1980. Electroshocking surveys were conducted, and the R-2 Cross method was applied to cross section measurements. The aquatic habitat was also evaluated using the WSP (Water Surface Profile) and IFG3 (or HABITAT model) methods to help determine necessary minimum streamflow levels.

Recommendations

After the initial 1978 field investigation, the FWS and CDWR stated that minimum flows of at least 75 cfs were necessary, but that more studies needed to be conducted to support higher minimum flows. Following the CDWR studies in 1979 and 1980, the CDWR stated that it could not recommend flows lower than 140 cfs for the Colorado River between Williams Fork River and Troublesome Creek. An original agreement was entered into in April of 1980 that specified minimum flows of 85 to 100, 120 to 140, and 140 to 160 cfs for the indicated locations on the Colorado River, respectively. Negotiations between the CDWR and NCCD continued until the final agreement was reached the following June.

The FWS never submitted formal recommendations (i.e., a FWCA report). A Biological Opinion was issued in 1981 after the minimum flow agreement had been reached.

Streamflow Records

A USGS gage is located on the first reach indicated (between Windy Gap and the mouth of the Williams Fork River); thus, we evaluated how often the minimum flow of 90 cfs has been maintained. The NCCD did install a gage to measure flows in the second reach, but problems with that gage have only recently been solved and we were not able to obtain flow records. A gage to measure flows in the third reach has not been installed.

Station: USGS
Period of record evaluated: 1985-1986

Percent of record showing streamflow discrepancies: 11.6
Percent of record showing streamflow discrepancies greater than 10 percent: 5.2
Percent of record showing streamflow discrepancies greater than 25 percent: 0.5
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

Streamflow data from 1985 and 1986 indicate that the 90 cfs has been maintained 88 percent of the time. There were some initial problems due to misinterpretation of the agreement. The operators had interpreted the agreement to mean a flow of 90 cfs immediately below Windy Gap Diversion, rather than a continuous flow of 90 cfs from Windy Gap down to the mouth of the Williams Fork River. According to NCCD, this problem has been solved.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Lakewood, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Personal Communications

Helbig, V. Retired, U.S. Fish and Wildlife Service, Lakewood, Colorado. May 1987.

McKee, C. Northern Colorado Conservancy District, Loveland, Colorado. June 1987.

References

Colorado Division of Wildlife. [Letter to Manager, Northern Colorado Water Conservancy District, Loveland, Colorado]. 1980 June 19.

Erickson, R. 1980. Response to concerns on aquatic systems potentially affected by the construction or operation of Windy Gap. Prepared for the Municipal Subdistrict, Northern Colorado Water Conservancy District. Unpublished report.

Nehring, B. 1980. Evaluation of trout habitat and discharge patterns for the Colorado River from the confluence with the Williams Fork River to the confluence with Troublesome Creek. Colorado Division of Wildlife. Unpublished report.

U.S. Fish and Wildlife Service, Regional Director. [Memorandum to Regional Director, Water and Power Resources Service, Lower Missouri River Basin, Denver, Colorado]. 1981 February 26.

U.S. Fish and Wildlife Service, Regional Director. [Memorandum to Regional Director, Water and Power Resources Service, Lower Missouri Region, Denver, Colorado]. 1981 February 26.

Rabbit Ears Creek Trans-Mountain Ditch
Colorado River Basin

Location	Diversion ditch is located on Rabbit Ears Creek, north of Kremmling in Grand County, Colorado.
Function	To supply supplemental irrigation water in July.
Completion Date	The ditch was constructed in 1967 and diverted water from Rabbit Ears Creek beginning in 1968.
Operators	Lynn and Thelma Matheson
Minimum Streamflow Agreement	A BLM right-of-way was granted to the Matheson's on November 14, 1967. A minimum streamflow below the diversion was a condition of the right-of-way.
Streamflow Releases	The operators must maintain a minimum streamflow of 4 cfs or the natural flow, whichever is less, below the point of diversion in Rabbit Ears Creek.
Objective	To prevent damage to the fish habitat in Rabbit Ears Creek and Troublesome Creek (approximately 4 miles downstream).
Information and Methods Used	A joint field inspection of the creek and proposed diversion site was conducted by the FWS and Colorado Department of Game, Fish and Parks (now CDWR).
Recommendations	The FWS reviewed the application for the BLM right-of-way and in a letter to BLM dated October 20, 1967 recommended a minimum bypass flow of 4 cfs or the natural flow. The FWS made three additional recommendations concerning the diversion structure including revegetating the site and providing public access for fishing and hunting. The Colorado Department of Game, Fish and Parks concurred with the recommendations made by the FWS. All the recommendations were included as conditions in the BLM right-of-way permit.
Streamflow Records	None

Agency Offices Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

References

Colorado Department of Game, Fish and Parks. [Letter to Regional Director, Bureau of Sport Fisheries, Albuquerque, New Mexico]. 1967 September 28.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Fish and Wildlife Service, Albuquerque, New Mexico. [Letter to State Director, Bureau of Land Management, Denver, Colorado]. 1967 October 20.

Blue Valley Ranch Hydro Power Project
Colorado River Basin

Location	Diversion dam is located on the Blue River between Green Mountain Dam and Kremmling in Granby County, Colorado.
Function	Run-of-river power generating facility
Completion Date	Blue Valley Ranch No. 1 was installed in December of 1983 and became operational in July of 1984. Blue Valley Ranch No. 2 has been approved by FERC and construction was to begin in June 1987, but this unit will not be operational until around 1991.
Operators	Trans Mountain Hydro Corporation
Minimum Streamflow Agreement	Blue Valley Ranch was licensed by FERC in July 1983. FERC license No. 3164, Article 22, requires minimum streamflow releases below the point of diversion.
Streamflow Releases	The conditions of Article 22 are that the licensee must release a continuous minimum flow of 30 cfs or the inflow , whichever is less, from the diversion structure. Minimum flows can be temporarily reduced if operating emergencies require such modifications, but the licensee must notify and consult the CDWR before doing so.
Objective	To protect and enhance the aquatic resources of the Blue River.
Information and Methods Used	The minimum streamflow amount was determined by the licensee, Trans Mountain Hydro Corporation, by evaluating flow records for the Blue River and determining 10 percent of the average flow.
Recommendations	The FWS and CDWR accepted the minimum streamflow, as proposed by the licensee, as being adequate to protect the downstream resources.
Streamflow Records	No streamflow records are available for the Blue River below the project's point of diversion. According to the licensee, streamflows are normally between 100 and 200 cfs, and the 30-cfs minimum has been maintained since the project became operational.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

Federal Energy Regulatory Commission, San Francisco, California.

Federal Energy Regulatory Commission, Washington, D.C.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

Personal Communications

Young, C. Trans Mountain Hydro Corporation, Golden, Colorado. May 1987.

References

Federal Energy Regulatory Commission. Order issuing license (minor), Trans Mountain Construction Company, Project No. 4316. 1983 July 6.

Breckenridge Ski Area Diversions
Colorado River Basin

Location	Breckenridge Ski Area is located in Breckenridge, Summit County, Colorado. A diversion structure is located on the Blue River near the confluence with the Swan River.
Function	Snow making operations (recreation)
Completion Date	1986
Operators	Breckenridge Ski Area, a division of Aspen Ski Company
Minimum Streamflow Agreement	Breckenridge Ski Area and the Colorado Department of Natural Resources entered into a Memorandum of Agreement on March 13, 1986. The agreement establishes minimum streamflows in the Blue River below the Breckenridge's point of diversion. Furthermore, Breckenridge Ski Area has agreed to support the State's filing for instream flows on the Blue River and not file a statement of opposition.
Streamflow Releases	The agreement established the following minimum instream flows: Blue River from about 5,200 feet above the confluence with Swan River downstream to the confluence with the Swan River: 20 cfs May 1 through October 31, 10 cfs during November, and 10 cfs December 1 through April 30. During the early winter (the month of October) Breckenridge can divert water such that the flows in the indicated reach can be below 20 cfs as long as there is at least 13 cfs. If water diversions cause the flow to go below 20 cfs, Breckenridge has agreed to not exceed an average diversion rate of 3 cfs within a 24-hour period. Likewise, during the late winter (December through April) Breckenridge can divert water such that the flows can go below 10 cfs but not less than 7 cfs. If diversions cause the flows to drop below 10 cfs, Breckenridge has agreed to fluctuate the diversions on a 12-hour on and 12-hour off schedule.
Objective	To protect and preserve the natural environment of the identified reach of the Blue River.
Information and Methods Used	The CDWR conducted a stream survey and applied the R-2 Cross method to determine the minimum instream flow needs.
Recommendations	We were not able to locate any documentation reflecting involvement by the FWS.

Streamflow Records	The agreement specified the point on the Blue River where the flows will be monitored, and Breckenridge agreed to install and maintain a gage and supply records to the State. We were not able to acquire streamflow data.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

Personal Communications

Putman, S. Colorado Division of Wildlife Resources, Denver, Colorado. May 1987.

Keystone Arapaho Diversions
Colorado River Basin

Location	Keystone and Arapaho ski areas are located near Dillon, Summit County, Colorado. Water diversion affects streamflows in the Snake River, North Fork of the Snake, and Keystone Gulch.
Function	Snow making operations and commercial uses primarily
Effective Date	1986
Operators	Keystone Arapaho Limited Partnership
Minimum Streamflow Agreement	Keystone's Master Plan established minimum bypass flows and was incorporated into a 1984 FS special use permit. In addition, Keystone Arapaho Limited entered into two Memoranda of Agreement in 1986 with the Colorado Department of Natural Resources. One agreement pertains to water diversions and minimum flows in the Snake River and the other to diversions and minimum flows in the North Fork Snake River and Keystone Gulch. Keystone Arapaho Limited also has agreed to support the State's instream flow filings on these streams and not file an opposing statement.
Streamflow Releases	The above FS permit and agreements established the following minimum flows: The Snake River from the confluence with the North Fork Snake River to Dillon Reservoir: 12.0 cfs May 1 through September 30, and 6.0 cfs October 1 through April 30. Keystone has the right to divert water between October 1 and April 30 at a rate which might cause the flows to go below 6 cfs, but in no event can the flows go below 2 cfs. Such circumstances are expected to be uncommon and only during low streamflow or low snowfall. North Fork Snake River below the falls down to the confluence with the Snake River: 3.5 cfs May 1 through October 30, and 2.0 cfs November 1 through April 30. Keystone Gulch from the headwaters to the confluence with the Snake River: 1.5 cfs. Arapaho Basin ski area can divert water between September 1 and April 30, which could cause flows in the North Fork to fall below 2 cfs, but in no event can diversions cause the flows to fall below 1.5 cfs. Apparently the minimum flow of 1.5 cfs on Keystone Gulch is not guaranteed. The State's rights are junior to the ski area's and the State has agreed not to try and condition the ski area's diversions for the benefit of the State's 1.5-cfs right.

	Keystone has agreed to install and operate a streamflow gage to measure flows on the Snake River, whereas the State has agreed to measure flows on the North Fork. A USGS gage already exists on Keystone Gulch.
Objective	To protect and preserve the natural environment of the Snake River, North Fork Snake River, and Keystone Gulch.
Information and Methods Used	The CDWR conducted a stream survey and applied the R-2 Cross method to determine the minimum instream flow needs.
Recommendations	In 1985 the FWS reviewed a COE 404 permit application by Keystone Arapaho to construct an intake structure on the Snake River. Initially, the FWS requested that the COE hold the permit in abeyance until the plans for the intake structure could be modified. Later that year, the FWS responded with a biological opinion of no jeopardy to the Colorado squawfish, humpback chub, and bony tail chub. No recommendations were made concerning minimum streamflows.
Streamflow Records	USGS streamflow records for the winter of 1986-1987 were not available at the time of this report.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

U.S. Forest Service, White River National Forest, Glenwood Springs, Colorado.

Personal Communications

Putman, S. Colorado Division of Wildlife Resources, Denver, Colorado. May 1987.

References

U.S. Fish and Wildlife Service. [Letter to U.S. Army Corps of Engineers, Sacramento District, California]. 1985 July 23.

U.S. Fish and Wildlife Service. [Letter to U.S. Army Corps of Engineers]. 1985 September 5.

U.S. Forest Service, White River National Forest. [Letter to Vice-President of Operations, Keystone]. 1986 October 15.

Copper Mountain Diversion
Colorado River Basin

Location	Copper Mountain ski area is located in Summit County, Colorado. A diversion structure for snow making operations is located on West Tenmile Creek, and affects streamflows in West Tenmile and Tenmile Creeks.
Function	Snow making operations (recreation)
Completion Date	Winter of 1986-1987
Operators	Copper Mountain, Inc.

Minimum Streamflow Agreement	Copper Mountain, Inc. entered into a Memorandum of Agreement with the Colorado Department of Natural Resources on March 11, 1986. The agreement establishes minimum instream flows below Copper Mountain's points of water diversion. The State of Colorado, through the Colorado Water Conservation Board, has filed on the instream flow amounts agreed to, and Copper Mountain, Inc. has agreed to support the State's filing and not file a competing application.
Streamflow Releases	The following minimum flows were established in the agreement: West Tenmile Creek from headwaters to confluence with Union Gulch: 5 cfs from April 1 through September 30, and 3 cfs from October 1 through March 31. West Tenmile Creek from Union Gulch to the confluence with Tenmile Creek: 5 cfs April 1 through September 30, and 2 cfs October 1 through March 31. Tenmile Creek from confluence with West Tenmile to Dillon Reservoir: 10 cfs April 1 through September 30, and 7 cfs October 1 through March 31. Copper Mountain can divert water between October 1 and March 31, and during this time flows in West Tenmile Creek to Union Gulch can go below 2 cfs as long as flows are at least 1.5 cfs. Likewise, flows in Tenmile Creek during this period can go below 7 cfs as long as the flow is at least 6 cfs. If streamflows go below 2 cfs and 7 cfs in the stated reaches, due to water diversions by Copper Mountain, Copper Mountain has agreed not to divert water at more than an instantaneous rate of 1.5 cfs.
Objective	To protect and preserve the natural environment of the identified stream segments.
Information and Methods Used	The CDWR applied the R-2 Cross method to West Tenmile and Tenmile Creeks to determine instream flow needs. In addition, IFIM was applied by a private consulting company, Chadwick Associates.
Recommendations	We were not able to locate any documents reflecting involvement by the FWS.
Streamflow Records	As part of the agreement, Copper Mountain will install and maintain stream gages necessary to monitor the conditions of the agreement. Diversion of water began in 1987, but streamflow data have not been available to date.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

Personal Communications

Putman, S. Colorado Division of Wildlife Resources, Denver, Colorado. May 1987.

Dillon Dam and Reservoir
Colorado River Basin

Location	Storage dam and reservoir are located on the Blue River, near Dillon in Summit County, Colorado.
Function	Water from the Blue River is stored in Dillon Reservoir and then transported across the Continental Divide via the Harold D. Roberts Tunnel into the South Platte River system. Water from the South Platte is diverted for municipal use by the Denver Water Board.

Completion Date	Dillon Dam was completed in 1963.
Operators	Denver Water Board
Minimum Streamflow Agreement	The BLM right-of-way for Dillon Dam and Reservoir contains stipulations (recommended by the FWS) for minimum streamflow releases from the reservoir into the Blue River. The Denver Water Board (DWB) approved the stipulations on August 9, 1966, two years after the dam was completed. In 1984 FERC issued an "Exemption from Licensing of a Small Hydroelectric Project" to the Denver Water Department for a small hydroelectric facility at Dillon Reservoir. The Department of Interior recommended that FERC include the minimum flows already existing into the license. Article 2 of all FERC exemption licenses requires that licensees comply with any terms and conditions determined by Federal and State fish and wildlife agencies.
Streamflow Releases	The BLM right-of-way stipulates a minimum release from Dillon Reservoir of 50 cfs or the natural flow, whichever is less, at all times except during operating emergencies and periods of maintenance or repairs. In addition, the minimum flow releases can be reduced if "at any time the combined volume of water in storage in Cheesman, Eleven Mile Canyon, Antero, and Dillon Reservoirs is not in excess of the DWB's estimate (as the same may be amended from time to time) of the current one calendar year's use of water through the Denver Water Works System, then a shortage shall be deemed to exist, during which time the releases provided for (50 cfs)...shall be reduced in direct proportion to the storage shortage." Furthermore, if available storage space in Dillon exceeds 100,000 acre-feet, the DWB can reduce the minimum flow releases. Other conditions concerning storage volume in the indicated reservoirs and water use restrictions are included in the right-of-way that allows the DWB to reduce the minimum flow releases.
Objective	To protect the fishery in the Blue River downstream from Dillon Reservoir.
Information and Methods Used	According to CDWR, the 50-cfs minimum streamflow release was based on historic streamflow records, the R-2 Cross method applied to channel measurements, and negotiations. The above evaluations were conducted around 1963-1964, before the BLM right-of-way was issued.
Recommendations	In October of 1964, the CDWR, in an informal meeting concerning bypass flows for Dillon Reservoir, stated that, based on the results of their studies, a 50-cfs minimum flow was necessary for the Blue River below Dillon Dam. Apparently the DWB was having difficulty with this recommendation because of low winter flows and the loss in storage a 50-cfs release would cost. Consequently, the FWS informally suggested that a release of 40 cfs be considered. The FWS reviewed the DWB's application for a BLM right-of-way and submitted formal recommendations to BLM in 1965. The FWS recommended a minimum flow from Dillon Reservoir of 35 cfs October to April and 65 cfs May to September or the natural inflow during both periods, whichever is less. After long negotiations between the FWS, CDWR, BLM, and the DWB, 50 cfs year-round was agreed to and incorporated into the right-of-way.
Streamflow Records	Downstream Station: USGS Period of record evaluated: 1967-1986 Percent of record showing streamflow discrepancies: 6.0 Percent of record showing streamflow discrepancies greater than 10 percent: 3.8 Percent of record showing streamflow discrepancies greater than 25 percent: 2.5 Percent of record showing streamflow discrepancies greater than 50 percent: 2.2 Percent of record showing streamflow discrepancies greater than 75 percent: 0.3

Upstream and downstream stations: USGS
Period of record evaluated: 1967-1986

Percent of downstream flow record showing streamflow discrepancies when inflows were at least 50 cfs on the same day: 2.6
Percent of record showing streamflow discrepancies greater than 10 percent: 2.6
Percent of record showing streamflow discrepancies greater than 25 percent: 1.6
Percent of record showing streamflow discrepancies greater than 50 percent: 0.8
Percent of record showing streamflow discrepancies greater than 75 percent: <0.1

Streamflows of at least 50 cfs have been maintained 94 percent of the time since 1967 when the BLM right-of-way was issued. Upstream flows were lower than 50 cfs over 50 percent of the time when releases from the reservoir were also less than 50 cfs. We were not able to evaluate how often low storage in the other indicated reservoirs, or other conditions of the right-of-way, resulted in reduced streamflow releases from Dillon.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Lakewood, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Personal Communications

Burkhart, W. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

Taylor, B. Denver Water Board, Environmental Section, Denver, Colorado. July 1987.

References

Denver Water Department. 1976. Features of the Denver Water System. Office of Public Affairs, Denver Water Department, Denver, Colorado.

River Basin Studies, Field Supervisor, Denver, Colorado. [Memorandum to Regional Director, Bureau of Sport Fisheries and Wildlife, Albuquerque, New Mexico]. 1964 October 4.

U.S. Fish and Wildlife Service. [Memorandum to State Director, Bureau of Land Management, Denver, Colorado]. 1965 September 14.

Fryingpan-Arkansas Project
Colorado and Mississippi River Basins

General Description The Fryingpan-Arkansas Project is a multi-facility, multi-purpose, trans-mountain diversion project, operated by the Bureau of Reclamation. Water is diverted from the headwaters of the Fryingpan River and other tributaries of the Colorado River on the west side of the Continental Divide and transported via tunnels and conduits into the Arkansas River system on the east side of the divide. The project provides water for irrigation in the Arkansas Valley; municipal and industrial water for population centers on the east slope of the Rockies in Colorado; power; and recreation, fish, and wildlife benefits.

Authorization

Investigations and project planning began in the late 1930's. The Operating Principles, developed by the BR, were adopted by the State of Colorado on April 30, 1959 (amended December 30, 1959, and December 9, 1960). The project was authorized for construction by Public Law 87-590 (77 Stat. 393) on August 16, 1962 and included recreation, fish, and wildlife as project benefits. Many of the minimum streamflows below points of diversion were originally established in the Operating Principles and thus became part of the Federal legislation authorizing construction. The project had been under construction for about five years when NEPA became effective. Even though project features were authorized, because not all had been constructed, the project was subject to NEPA and an environmental review process was initiated. The Final Environmental Statement was completed in 1975.

Facilities

Western slope facilities include Ruedi Dam and Reservoir, located on the Fryingpan River, and an extensive collection system to divert water from the Fryingpan and Roaring Fork Rivers (tributaries of the Colorado River) into the Charles H. Boustead Tunnel. The tunnel conveys water over the Continental Divide to Turquoise Lake on the east slope. Turquoise Lake and Sugar Loaf Dam are located on Lake Fork Creek (tributary of the Arkansas River) and regulate and store water coming from the west slope. Water from Turquoise Lake is conveyed through a conduit to Mt. Elbert Forebay through a power generating facility and then into Twin Lakes. Water from Twin Lakes is used for power generation at Mt. Elbert Forebay.

Pueblo Dam and Reservoir are located downstream from Turquoise and Twin Lakes on the Arkansas River. This feature of the Fryingpan-Arkansas Project will not be discussed as there are no minimum streamflow releases from Pueblo for fish and wildlife benefits.

Five features of the Fryingpan-Arkansas Project will be described: Ruedi Dam and Reservoir, Westslope Collection System, Grizzly and Roaring Fork Diversions (3,000 acre-foot exchange agreement between the BR and Twin Lakes Reservoir and Canal Company), Turquoise Lake and Sugar Loaf Dam, and Twin Lakes Dam and Reservoir.

Ruedi Dam and Reservoir
Fryingpan-Arkansas Project
Colorado River Basin

Location

Storage dam and reservoir are located on the Fryingpan River, east of Basalt in Eagle and Pitkin Counties, Colorado.

Function

Provides irrigation and municipal water for communities on the west slope of Colorado.

Completion Date

Construction on the dam began in 1964 and was completed in 1968.

Operators

Bureau of Reclamation

Minimum Streamflow Agreement

Minimum streamflow releases from Ruedi Reservoir were established in the Operating Principles adopted by the State of Colorado in 1959 and subsequently incorporated into the 1962 Federal authorizing legislation.

Streamflow Releases

The official minimum streamflows for the Fryingpan River below Ruedi Reservoir are:

November 1 through April 30	39 cfs or the native inflow, whichever is less,
May 1 through October 31	110 cfs or native inflow, whichever is less.

In 1970, the CDWR requested that minimum flows below Ruedi Reservoir be maintained at 100 cfs September 1 through November 15. The BR maintains these flow levels whenever possible.

Objective

For the protection of recreational and fishing values on the Fryingpan River. Minimum flows requested by the CDWR address spawning habitat for brown trout.

Information and Methods Used

The original minimum streamflows below Ruedi Reservoir were developed by the BR, FWS, and Colorado Department of Game and Fish (now CDWR). The FWS and CDWR conducted aquatic studies on the Fryingpan River below Ruedi Reservoir beginning in 1969-1970. Transects were used to measure hydraulic characteristics at various flows. A tag line was stretched across the river to measure water depth and velocity. Biological surveys were conducted to locate spawning redds of brown trout. Results supported some of the original minimum streamflow determinations and suggested some modifications (i.e., maintaining 100 cfs September 1 through November 15).

Recommendations

The original minimum streamflows instituted reflect flows recommended by the FWS and CDWR. After construction, the FWS and CDWR continued studies on the Fryingpan River, and in the early 1970's recommended modified minimum streamflows to improve the downstream fishery specifically for spawning brown trout. A minimum flow of 100 cfs from October 15 (or as much as two weeks earlier) through November 15 was recommended for spawning brown trout. Minimum flows of 100 cfs from November 15 through July 1 were also recommended for early spawning rainbow trout and incubating brown trout. The BR tries to maintain minimum streamflows of 100 cfs from September 1 through November 15. The second recommendation was not fully instituted. The existing flow releases already provided minimum flows of 110 cfs May to July 1 and on through October.

Streamflow Records

Station: USGS
Period of record evaluated: 1968-1986
Flow amounts evaluated: 39 cfs November 1 - April 30, and 110 cfs May 1 - October 31

Percent of record showing streamflow discrepancies: 13.0
Percent of record showing streamflow discrepancies greater than 10 percent: 6.8
Percent of record showing streamflow discrepancies greater than 25 percent: 4.0
Percent of record showing streamflow discrepancies greater than 50 percent: 1.2
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Streamflow records immediately above the reservoir are not available; thus, we could not evaluate how often upstream flows were below the minimum flow amounts indicated. Representatives from the BR indicate that low upstream flows account for most of the occasions when minimum flow releases can not be met.

Westslope Collection System
Fryingpan-Arkansas Project
Colorado River Basin

Location

The Westslope Collection System consists of a series of diversion dams located on headwater streams of the Fryingpan and Roaring Fork Rivers in Eagle and Pitkin Counties, Colorado. Twelve of the diversions have minimum bypass flows and will be described herein. Locations of the twelve diversion dams are as follows:

Fryingpan River System
- Chapman Gulch
- South Fork of the Fryingpan River
- Fryingpan River
- Ivanhoe Creek
- North Cunningham Creek
- Middle Cunningham Creek
- Carter Creek
- Morman Creek
- North Fork (of Savage Creek)

Roaring Fork River
    Hunter Creek
    Midway Creek
    No Name Creek

Function

Water is diverted from the indicated creeks into various tunnels on the west slope, which convey water to the Charles H. Boustead Tunnel. This tunnel transports water over the Continental Divide to the Arkansas River Basin. The Westslope Collection System provides water for multiple uses including municipal, industrial, power, and irrigation.

Completion Dates

The following dates indicate initial water diversions.

Chapman Diversion Dam	1972
South Fork Diversion Dam	1972
Fryingpan Diversion Dam	1972
Ivanhoe Diversion Dam	1976
North Cunningham Diversion Structure	1979
Middle Cunningham Diversion Structure	1979
Carter Diversion Structure	1980
Morman Diversion Structure	1979
North Fork Diversion Structure	1980
Hunter Diversion Structure	1980
Midway Diversion Structure	1980
No Name Diversion Structure	1980

Operators

Bureau of Reclamation

Minimum Streamflow Agreement

A collective minimum streamflow amount for the Fryingpan River diversions was established in the BR's Operating Principles in 1959. This meant that the diversions would have to be regulated in such a manner so that each tributary would be contributing to the minimum flow amount in a proportion equal to their natural flow conditions. Subsequently, the collective minimum flow requirement was incorporated into the Federal authorizing legislation for the project. As planning for the project proceeded, specific minimum flows below each diversion point were determined.

Minimum streamflows below water diversions on the Roaring Fork were not included in the Operating Principles. On October 14, 1978 the Authorizing Act of August 16, 1962, Public Law 87-590 (76 Stat. 393) was amended by Congress to include minimum flows for Hunter, Midway, and No Name Creeks.

In 1979 the COE issued 404 permits for Carter, North Fork, Morman, North Cunningham, Middle Cunningham, Hunter, Midway, and No Name Creeks. The permits do not state the specific flow releases for the indicated streams, but recognize that minimum flow requirements have been established by the Operating Principles and agreements between the State of Colorado, Southeastern Colorado Water Conservancy District, City of Aspen, and Pitkin County. The agreements with the State of Colorado address instream flow filings by CDWR for the minimum flow amounts required by the Operating Principles. The agreements also establish cooperation from local city and county governments to support the filings and encourage the CDWR to continue aquatic studies to determine necessary flow requirements for preservation of aquatic habitat, fish production, and recreation.

Streamflow Releases

Minimum streamflow releases (or the natural flow) below the following diversions are to be maintained from April 1 through September 30. This period represents the months during which the BR can divert water.

Chapman	3 cfs
South Fork	6 cfs
Fryingpan	12 cfs
Ivanhoe	3 cfs
North Cunningham	1 cfs

Middle Cunningham	1 cfs
Carter	2 cfs
Morman	2 cfs
North Fork	1 cfs
Hunter	12 cfs
Midway	5 cfs
No Name	4 cfs

In addition, at the Thomasville USGS gage on the Fryingpan River the following minimum flows or the natural flow, whichever is less, are required:

April	100 cfs
May	150 cfs
June	200 cfs
July	100 cfs
August	75 cfs
September	70 cfs

Objective

1959 Operating Principles: To maintain existing and future beneficial uses including recreational and fishing values.

Information and Methods Used

In 1972, the FWS and CDWR had completed initial stream surveys that included electrofishing, aquatic habitat, hydrologic (using Q-17 or 17th percentile of flow duration curves), and water quality studies on most of the streams to be impacted by the project. Stream studies were continued, and in 1977 the CDWR determined minimum bypass flows for Chapman, South Fork, Fryingpan, Ivanhoe, Morman, North Cunningham, Carter, and North Fork Creeks. In 1977, the FWS, FS, and CDWR conducted flow studies using the R-2 Cross method on Hunter, Midway, and No Name Creeks. In 1978, the FWS, CDWR, FS, and BR participated in stream surveys on Carter, North Fork, Mormon, and North and Middle Cunningham Creeks to reevaluate previously established minimum bypass flows. The R-2 Cross (modified-sag tape) method was applied. The minimum streamflows were based on the above studies and negotiations with the BR.

Recommendations

Determination of minimum streamflows for the Collection System was a long and complicated process involving the BR, FWS, CDWR, FS, and other concerned parties. Recommendations from the FWS, CDWR, and FS concerning minimum streamflows were offered at various times for various streams, and were changed as more information was collected and as negotiations with the BR proceeded. For example, in 1964 the FWS stated that bypass flows below South Cunningham, Carter, and Morman Creeks were not necessary as long as the BR maintained the collective minimum flow in the Fryingpan River. Ten years later, the FWS wanted to reevaluate releases below the three streams, and minimum flows were eventually instituted.

When the BR applied for COE 404 permits, the FWS, CDWR, and FS reevaluated some of the previously determined minimum bypass flow amounts. As a result, recommendations were made for slightly higher bypass flows on Carter, North Fork, and North and Middle Cunningham Creeks, but the higher flow amounts were not accepted by the BR.

In 1972, the FWS recommended flows of 12, 6, and 3 cfs below the Fryingpan, South Fork, and Chapman diversions, respectively. These flow amounts were instituted by the BR as recommended.

We could not devote enough time to thoroughly trace the recommendation process concerning minimum streamflows for the Westslope Collection System. Thus, the above information is not complete.

Biological Evaluation

Some of the streams may be appropriate for biological evaluation of the effectiveness of the minimum bypass streamflows. These are headwater streams with few upstream disturbances; however, some stream habitat improvement work has been done (e.g., Fryingpan River). Predevelopment biological data, including estimates of fish per acre, are available for some of the streams.

Streamflow Records

Stream: Chapman, 3 cfs
Station: USGS and State
Period of record evaluated: 1973-1985

Percent of record showing streamflow discrepancies: 20.7
Percent of record showing streamflow discrepancies greater than 10 percent: 19.2
Percent of record showing streamflow discrepancies greater than 25 percent: 13.6
Percent of record showing streamflow discrepancies greater than 50 percent: 6.4
Percent of record showing streamflow discrepancies greater than 75 percent: 0.4

Stream: South Fork, 6 cfs
Station: USGS and State
Period of record evaluated: 1973-1983

Percent of record showing streamflow discrepancies: 21.0
Percent of record showing streamflow discrepancies greater than 10 percent: 15.8
Percent of record showing streamflow discrepancies greater than 25 percent: 11.7
Percent of record showing streamflow discrepancies greater than 50 percent: 6.2
Percent of record showing streamflow discrepancies greater than 75 percent: 0.2

Stream: Fryingpan River near Ivanhoe Lake, 12 cfs
Station: USGS and State
Period of record evaluated: 1973-1983

Percent of record showing streamflow discrepancies: 23.4
Percent of record showing streamflow discrepancies greater than 10 percent: 20.7
Percent of record showing streamflow discrepancies greater than 25 percent: 14.7
Percent of record showing streamflow discrepancies greater than 50 percent: 7.4
Percent of record showing streamflow discrepancies greater than 75 percent: 0.2

Stream: Ivanhoe, 3 cfs
Station: USGS and State
Period of record evaluated: 1976-1983

Percent of record showing streamflow discrepancies: 65.8
Percent of record showing streamflow discrepancies greater than 10 percent: 59.8
Percent of record showing streamflow discrepancies greater than 25 percent: 49.1
Percent of record showing streamflow discrepancies greater than 50 percent: 28.8
Percent of record showing streamflow discrepancies greater than 75 percent: 14.5

Stream: North Cunningham, 1 cfs
Station: BR
Period of record evaluated: 1979-1985

Percent of record showing streamflow discrepancies: 0.0

Stream: Middle Cunningham, 1 cfs
Station: BR
Period of record evaluated: 1979-1986

Percent of record showing streamflow discrepancies: 2.2
Percent of record showing streamflow discrepancies greater than 10 percent: 1.3
Percent of record showing streamflow discrepancies greater than 25 percent: 0.7
Percent of record showing streamflow discrepancies greater than 50 percent: 0.4
Percent of record showing streamflow discrepancies greater than 75 percent: 0.2

Stream: Carter, 2 cfs
Station: BR
Period of record evaluated: 1980-1986

Percent of record showing streamflow discrepancies: 22.3

Percent of record showing streamflow discrepancies greater than 10 percent: 11.3
Percent of record showing streamflow discrepancies greater than 25 percent: 0.0

Stream: Morman, 2 cfs
Station: BR
Period of record evaluated: 1979-1986

Percent of record showing streamflow discrepancies: 4.9
Percent of record showing streamflow discrepancies greater than 10 percent: 3.2
Percent of record showing streamflow discrepancies greater than 25 percent: 1.3
Percent of record showing streamflow discrepancies greater than 50 percent: 0.9
Percent of record showing streamflow discrepancies greater than 75 percent: 0.4

Stream: North Fork, 1 cfs
Streamflow records: None

Stream: Hunter, 12 cfs
Station: BR
Period of record evaluated: 1980-1986

Percent of record showing streamflow discrepancies: 36.8
Percent of record showing streamflow discrepancies greater than 10 percent: 32.1
Percent of record showing streamflow discrepancies greater than 25 percent: 25.2
Percent of record showing streamflow discrepancies greater than 50 percent: 5.0
Percent of record showing streamflow discrepancies greater than 75 percent: 1.6

Stream: Midway, 5 cfs
Station: BR
Period of record evaluated: 1980-1986

Percent of record showing streamflow discrepancies: 17.6
Percent of record showing streamflow discrepancies greater than 10 percent: 10.9
Percent of record showing streamflow discrepancies greater than 25 percent: 7.3
Percent of record showing streamflow discrepancies greater than 50 percent: 1.3
Percent of record showing streamflow discrepancies greater than 75 percent: 0.2

Stream: No Name, 4 cfs
Station: BR
Period of record evaluated: 1980-1985

Percent of record showing streamflow discrepancies: 28.4
Percent of record showing streamflow discrepancies greater than 10 percent: 25.2
Percent of record showing streamflow discrepancies greater than 25 percent: 15.6
Percent of record showing streamflow discrepancies greater than 50 percent: 4.6
Percent of record showing streamflow discrepancies greater than 75 percent: 0.6

Stream: Fryingpan River at Thomasville: April 100 cfs, May 150 cfs, June 200 cfs, July 100 cfs, August 75 cfs, September 70 cfs.
Station: USGS
Period of record evaluated: 1976-1986

Percent of record showing streamflow discrepancies: 37.9
Percent of record showing streamflow discrepancies greater than 10 percent: 31.5
Percent of record showing streamflow discrepancies greater than 25 percent: 23.5
Percent of record showing streamflow discrepancies greater than 50 percent: 10.0
Percent of record showing streamflow discrepancies greater than 75 percent: 1.6

Streamflow records for North Cunningham, Middle Cunningham, Carter, Morman, Hunter, Midway, and No Name Creeks were provided by the BR. Streamflows were recorded only when the BR was diverting water, thus our evaluations represented how often the minimum flows were maintained while water was being diverted and not at any other time. The natural streamflow is bypassed when diversions are not being made. There is no streamflow gage below the North Fork diversion. According to the BR, the valve is set to bypass the minimum streamflow amount at all times.

For the remainder of the diversions, streamflow records were obtained from the USGS and Colorado State Engineer's Office. For these streams we did not have information indicating when diversions were being made, thus we evaluated the period from April 1 through September 30. According to the BR, diversions normally do not begin until May or June, but at times diversions are made as early as April.

Upstream flow records were not available; thus, we were not able to determine how often the natural flow was below the minimum bypass amount. Information from the BR, FWS, and CDWR indicates that low natural flows may be primarily responsible for the high frequency of discrepancies on some streams. In addition, comparisons between the above streams reveal that discrepancies were much lower for streams where we were able to discriminate when diversions were being made.

Situations may exist where the gates have been set to release the minimum bypass amount but as the streamflow changes the amount bypassed also changes. These situations can not be remedied immediately because the gates have to be manually reset and it takes time to access some of the areas in order to check and reset the gates.

Grizzly and Roaring Fork Diversions
3,000 Acre-feet Exchange
Fryingpan-Arkansas Project
Colorado River Basin

Location	Grizzly Diversion is located on Lincoln Creek, and Roaring Fork (or Lost Man) Diversion is located on the Roaring Fork River, southeast of Aspen in Pitkin County, Colorado.
Function	Twin Lakes Reservoir and Canal Company (TLRCC) operates a trans-mountain diversion project on the headwaters of the Roaring Fork River. Water is diverted from the Roaring Fork River and Lincoln Creek, stored in Grizzly Reservoir on Lincoln Creek, and then transported through a tunnel over the Continental Divide into Lake Creek and eventually to Twin Lakes on the eastern slope. When the Fryingpan-Arkansas project was authorized in 1962, a 3,000 acre-feet exchange of water between these two projects was established in the Operating Principles, and subsequently the authorizing legislation. The exchange provides TLRCC with 3,000 acre-feet of water for use on the eastern slope (from the BR operations and diversions transporting water into Twin Lakes) in exchange for the equivalent release from TLRCC diversion facilities on the Roaring Fork System. It was determined that the 3,000 acre-feet should be allocated between Lincoln Creek and Roaring Fork below Grizzly and Roaring Fork Diversions. The exchange helps to maintain flows in the Roaring Fork River, which were also established in the Operating Principles.
Completion Date	TLRCC diversion facilities were completed in 1937. The first year of the exchange was in 1981.
Operators	Bureau of Reclamation and TLRCC
Minimum Streamflow Agreement	The 3,000 acre-foot exchange was established in the 1959 Operating Principles for the Fryingpan-Arkansas Project, and subsequently was mandated by the authorizing legislation of 1962. Initial exchange took place in 1981, but a release schedule had not been agreed upon. Releases from 1984 through 1986 were experimental and a final schedule was accepted by the BR in 1987. The release schedule has been incorporated into the BR's operating criteria for the Fryingpan-Arkansas Project.

Streamflow Releases

The experimental streamflow releases (in cfs) below the diversions for 1984, 1985, and 1986 were:

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Grizzly	3	2	2	2	2	2	2	2	2.5	3	5	6
Roaring Fork	3	0	0	0	0	0	0	1	1.5	1.5	4	5

The final minimum streamflow release schedule accepted in 1987 is:

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Grizzly	4	4	4	3	2	2	2	2	2	2	3	4
Roaring Fork	4	0	0	0	0	0	0	1	1.5	1.5	4	4

Objective

Provide the best fishery habitat available within the constraints of 3,000 acre-feet.

Information and Methods Used

In 1972 the FWS, CDWR, and FS conducted aquatic studies by having TLRCC release certain flow levels and then examining fish habitat. Collection of field data was continued by the FS and CDWR in 1974 and 1976, respectively. In 1978 the FS collected additional hydrologic measurements at channel cross section sites that had been established in 1974. The R-2 Cross method was applied, and the drainage area was analyzed to estimate water yield. In 1984, the FWS began a monitoring program to evaluate the experimental flow release schedule and fish populations. Fish populations were monitored by electrofishing.

Streamflow Records

Stream: Flows below Grizzly Diversion on Lincoln Creek were evaluated according to the 1984-1986 release schedule.
Station: USGS
Period of record evaluated: 1984-1986

Percent of record showing streamflow discrepancies: 11.7
Percent of record showing streamflow discrepancies greater than 10 percent: 6.8
Percent of record showing streamflow discrepancies greater than 25 percent: 2.9
Percent of record showing streamflow discrepancies greater than 50 percent: 0.7
Percent of record showing streamflow discrepancies greater than 75 percent: 0.3

Stream: Flows below the Roaring Fork Diversion were evaluated according to the 1984-1986 release schedule.
Station: USGS
Period of record evaluated: 1984-1986

Percent of record showing streamflow discrepancies: 11.6
Percent of record showing streamflow discrepancies greater than 10 percent: 10.3
Percent of record showing streamflow discrepancies greater than 25 percent: 7.8
Percent of record showing streamflow discrepancies greater than 50 percent: 3.8
Percent of record showing streamflow discrepancies greater than 75 percent: 1.4

Streamflow records for water year 1987 were not available. Minimum streamflows below both diversions were maintained about 88 per cent of the time. No upstream flow records are available; thus, we could not evaluate how often upstream flows were less than the minimum bypass amounts.

Sugar Loaf Dam and Turquoise Lake Reservoir
Fryingpan-Arkansas Project
Mississippi River Basin

Location	Storage dam and reservoir are located on Lake Fork (tributary of the Arkansas River) near Leadville in Lake County, Colorado.
Function	The lake provides storage for water being transported from the west slope, and provides water for transport through the Mt. Elbert Conduit to the Mt. Elbert Powerplant.
Completion Date	Construction on the dam began in 1965 and was completed in 1968.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	The minimum streamflow below Sugarloaf Dam was not a part of the original Operating Principles authorized by Public Law 87-590 in 1962. The flows were established around the time that the Final Environmental Statement was completed in 1975. Since that time the minimum flows below Sugarloaf Dam have been incorporated into the BR operating criteria.
Streamflow Releases	Since 1979, the minimum streamflow release from Turquoise Lake into Lake Fork Creek has been 15 cfs or the natural inflow, whichever is less. When the BR completed the dam in 1968 the flow releases were 10 cfs May through September and 3 cfs October through April. This release schedule was continued until 1978, when flows were increased to 15 cfs May through September. In 1979, 15 cfs year-round was incorporated into the operating procedures.
Objective	To maintain the historic fishery in Lake Fork, and provide adequate flows for pollution abatement in the Arkansas River. Pollution from mining operations enters the Arkansas River via California Gulch located upstream from the confluence of Lake Fork with the Arkansas River.
Information and Methods Used	Evidently no stream studies were conducted on Lake Fork below the reservoir to determine minimum streamflows. According to information from the FWS, the minimum flow was based on streamflow records and a flow duration curve.
Recommendations	In 1962 the FWS recommended a minimum flow release into Lake Fork of 10 cfs May 15 through October 31, and 3 cfs the remainder of the year. The FWS stated that the releases should only be considered an interim schedule until recommendations were received concerning pollution abatement. In 1969, the recommendation was modified by the FWS to 15 cfs during the summer months and 3 cfs during the winter. This particular release schedule was included in the Final Environmental Statement for the project in 1975. Apparently, the BR did not incorporate the 15-cfs release into project operations until 1978. In 1979, the BR began releasing 15 cfs or the natural flow, whichever is less, year-round.
Streamflow Records	Station: State Engineers Office Period of record evaluated: 1968-1977, 10 cfs May - September, 3 cfs October - April; 1978, 15 cfs May - September, 3 cfs October - April; 1979-1986, 15 cfs year-round Percent of record showing streamflow discrepancies: 27.2 Percent of record showing streamflow discrepancies greater than 10 percent: 23.1 Percent of record showing streamflow discrepancies greater than 25 percent: 19.4 Percent of record showing streamflow discrepancies greater than 50 percent: 15.4 Percent of record showing streamflow discrepancies greater than 75 percent: 7.5 No upstream records are available; thus, we were not able to evaluate how often upstream flows were below the minimum release amount. According to operators located at Mt.

Elbert Powerplant station, streamflows above Turquoise Lake are down to around 3 cfs by the end of October and remain low throughout the winter.

Twin Lakes Dam and Reservoir
Fryingpan-Arkansas Project
Mississippi River Basin

Location	Storage dam and reservoir are located on Lake Creek south of Leadville near Granite in Lake County, Colorado.
Function	Water is pumped from Twin Lakes into Mt. Elbert Forebay (located north of Twin Lakes) for power generation at Mt. Elbert Powerplant located on the northwest corner of Twin Lakes. Water not in demand flows down into Pueblo Reservoir for use in the Arkansas Valley.
Completion Date	The BR began construction on the old dam in 1978 and the embankment was completed in 1979. Operations at Twin Lakes Dam began in 1981.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	Minimum streamflows below Twin Lakes Dam and Reservoir were not provided for in the original Operating Principles or the project authorization. Streamflows below Twin Lakes became an issue in the 1970's during the preparation of the Final Environmental Statement. Before the dam was completed in 1979, the BR had accepted recommendations for a minimum release from Twin Lakes Reservoir and incorporated the release into the operating procedures. In addition, the minimum flow release was incorporated into the COE 404 permit issued in 1978.
Streamflow Releases	The minimum flow release from Twin Lakes is 15 cfs or the natural inflow, whichever is less.
Objective	To maintain the downstream fishery, specifically spawning habitat for brown trout.
Information and Methods Used	In 1973, the CDWR conducted a study on Lake Creek below Twin Lakes. Streamflows were varied in order to observe changes in stream habitat conditions and fish populations.
Recommendations	The FWS did not recommend minimum streamflows below Twin Lakes in their FWCA report of 1969. In 1973, representatives from the BR, FWS, CDWR, and FS met to discuss the desirability of minimum streamflow releases from Twin Lakes. In October of 1973, the CDWR conducted the above study and stated that an optimum flow of 15 cfs would be necessary to maintain the fishery. By the time the Final Environmental Statement had been prepared, the FWS had not yet officially recommended the 15 cfs.
Streamflow Records	Downstream Station: State Engineers Office Period of record evaluated: 1979-1986 Percent of record showing streamflow discrepancies: 13.9 Percent of record showing streamflow discrepancies greater than 10 percent: 13.2 Percent of record showing streamflow discrepancies greater than 25 percent: 11.4 Percent of record showing streamflow discrepancies greater than 50 percent: 4.0 Percent of record showing streamflow discrepancies greater than 75 percent: 0.3 Upstream Station: USGS Period of record evaluated: 1979-1985 Percent of downstream flow record showing streamflow discrepancies when upstream flows were at least 15 cfs on the same day: 3.8 Percent of record showing streamflow discrepancies greater than 10 percent: 3.6

Percent of record showing streamflow discrepancies greater than 25 percent: 2.9
Percent of record showing streamflow discrepancies greater than 50 percent: 0.9
Percent of record showing streamflow discrepancies greater than 75 percent: 0.1

Low upstream flows correlated with a high percentage of days when releases from Twin Lakes Reservoir were below 15 cfs. The years with the highest frequencies of flow discrepancies were immediately following the completion of the dam. It appears that low upstream flows and reservoir filling operations have been the primary factors associated with reservoir releases below 15 cfs.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Bureau of Reclamation, Loveland Projects Office, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Lakewood, Colorado.

U.S. Forest Service, White River National Forest, Glenwood Springs, Colorado.

Personal Communications

Gibbons, T. Bureau of Reclamation, Water and Land Group, Loveland Projects Office, Colorado. March 1987.

Haegle, M. Bureau of Reclamation, Environmental Section, Loveland Projects Office, Colorado. March 1987.

Helbig, V. Retired, Fish and Wildlife Service, Denver, Colorado. October 1987.

Killgore, D. Bureau of Reclamation, Reservoir Operations, Loveland Projects Office, Colorado. April 1987.

Price, G. Bureau of Reclamation, Water and Land Group, Loveland Projects Office, Colorado. March 1987.

Swett, D. Bureau of Reclamation, Mt. Elbert Powerplant Station. January 1988.

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Hoppe, R., and L. Finnel. 1970. Aquatic studies on the Fryingpan River, Colorado, 1969-1970. U.S. Bureau of Sport Fisheries and Wildlife, Division of River Basin Studies. Unpublished report.

U.S. Bureau of Reclamation. [Letter to Director, Colorado Division of Wildlife, Denver, Colorado]. 1973 March 15.

U.S. Bureau of Reclamation. [Letter to Regional Director, Bureau of Sport Fisheries and Wildlife, Denver, Colorado]. 1973 April 13.

U.S. Bureau of Reclamation. 1975. Fryingpan-Arkansas Project, final environmental statement (volume I). U.S. Department of Interior, Bureau of Reclamation.

U.S. Bureau of Reclamation. [Letter to Area Manager, Fish and Wildlife Service, Salt Lake City, Utah]. 1978 December 6.

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U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Bureau of Reclamation, Region 7, Denver, Colorado]. 1962 February 7.

U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Bureau of Reclamation, Region 7, Denver, Colorado]. 1969 August 28.

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U.S. Fish and Wildlife Service. [Letter to District Engineer, Department of Army Corps of Engineers, Albuquerque, New Mexico]. 1978 October 13.

U.S. Fish and Wildlife Service. [Letter to Chairman, Fryingpan/Arkansas Commission, Denver, Colorado]. 1978 December 11.

U.S. Fish and Wildlife Service, Assistant Field Supervisor, Ecological Services. [Memorandum to Project Manager, Bureau of Reclamation, Pueblo, Colorado]. 1984 November 2.

U.S. Fish and Wildlife Service, Ecological Services. [Memorandum to Project Manager, Bureau of Reclamation, Pueblo, Colorado]. 1986 June 5

U.S. Fish and Wildlife Service. [Memorandum to Project Manager, Bureau of Reclamation, Pueblo, Colorado]. 1987 January 13.

U.S. Forest Service, Rocky Mountain Region. [Letter to Area Manager, Fish and Wildlife Service, Salt Lake City, Utah]. 1978 November 2.

Taylor Park Dam and Reservoir
Uncompahgre Project
Colorado River Basin

Location	Storage dam and reservoir are located on the Taylor River, 30 miles northeast of Gunnison in Delta County, Colorado.
Function	Irrigation
Completion Date	Construction on the Taylor Park Dam began in 1935 and was completed in 1937.
Operators	The BR constructed the project and turned over operations to the Uncompahgre Valley Water Users Association. Operation of the project is subject to operating criteria determined by the Bureau of Reclamation.
Minimum Streamflow Agreement	Provisions for minimum streamflows below Taylor Park Reservoir were established in the Taylor Park Reservoir Operation and Storage Exchange Agreement of August 28, 1975 between the United States (BR), Uncompahgre Valley Water Users Association, Upper Gunnison River Water Conservancy District, and the Colorado River Water Conservation District. The agreement provides for the exchange of water between Taylor Park and three downstream BR reservoirs (Blue Mesa, Morrow Point, and Crystal) to, among other things, optimize fishery conditions below Taylor Park and better manage available water supplies.
Streamflow Releases	No specific streamflow releases are stated in the agreement. The agreement reads: "In order to provide fishery benefits in Taylor Reservoir and in downstream reaches, the Association, except when unable to so operate due to Acts of God or emergency conditions, will release storage water from Taylor Park Reservoir at rates which will optimize fishery conditions in and below the reservoir area. The operating goal...will

be to stabilize Taylor River and Gunnison River flows through the year, to provide flood control and irrigation uses, and eliminate as much as possible abrupt changes that would adversely affect the fishery...".

While not included in the agreement, the BR tries to maintain stable flows from October through March of 50 to 250 cfs.

Objective

Provide stable flows for brown trout spawning.

Information and Methods Used

The CDWR initiated stream studies on the Taylor River below the reservoir in 1973. Electrofishing studies were conducted to establish brown trout population levels. The electrofishing surveys were resumed in 1979 and continued through 1982 in order to identify what effect the more stable flow regime might have had on brown trout. In addition, the CDWR conducted an IFG4 analysis on the Taylor River in 1981. Even though the electrofishing studies in the early 1970's were used to help establish the minimum flow agreement and amount of the flow releases, the studies following the agreement were essential in supporting the original determinations and maintaining the agreement. Since there were no specific flows specified in the agreement, these additional studies were necessary to provide data that assured the BR and other water users that the goal of the agreement was being achieved and that the releases needed to be maintained. In addition, the post-agreement studies provide information that can be used to improve reservoir releases for the brown trout fishery.

Recommendations

In 1967 the CDWR made recommendations to the BR to operate Taylor Reservoir in order to stabilize the reservoir elevation during the recreation season and increase streamflows during the winter. Tentative recommendations were made for releases of 150 cfs March through July, 100 cfs August through October, and 300 cfs November through February. In 1970, in a letter to the FS, the CDWR stated that flows of 200 to 300 cfs May through September and 150 cfs October through February would maintain an excellent fishery. After the initial studies by the CDWR (1973-1975), a flow regime was proposed that would stabilize flows from October through February rather than the previous release schedule that drastically reduced flows after November and through to February. After the BR changed the flow releases in 1975 and the CDWR monitored brown trout populations, the CDWR in 1980 stated that stable flows somewhere in the range of 50 to 250 cfs October through March would be acceptable during this critical period for brown trout. In the early drafts of the agreement, specific flows of 100 cfs June 1 through October 31, and 50 cfs November 1 through May 31 were included. The final agreement did not include any specific flow releases. Apparently the water users wanted more flexibility in the agreement. According to the CDWR and BR, the agreement is working very well and the two agencies cooperate closely to maintain acceptable flows for brown trout and other resources.

The FWS was involved in drawing up the agreement between the BR and the various water users, but the FWS did not make any official recommendations. Taylor Park Reservoir began operating before the FWCA was passed; thus, the FWS did not review the original plans, and evidently there have not been any recent modifications that would require a Federal review.

Biological Evaluation

The CDWR has collected brown trout population data to compare conditions before and after changes in the operation of Taylor Park Reservoir. The data indicate that the brown trout population increased 60 to 75 percent after the flows in the Taylor River were stabilized between 50 and 250 cfs.

Streamflow Records

Station: USGS
Period of record evaluated: 1976-1986

50 cfs
Percent of record showing streamflow discrepancies: 1.0
Percent of record showing streamflow discrepancies greater than 10 percent: 0.3
Percent of record showing streamflow discrepancies greater than 25 percent: 0.1
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

For the primary analysis, we examined how often the minimum of the desired range of flows, 50 cfs, was maintained during the critical period of October through March. Flows of at least 50 cfs were maintained 99 percent of the time, and flows were never below 27 cfs.

We also considered how often the flows were outside of the 50 to 250 cfs range. Flows were maintained within this range about 94 percent of the time since the agreement was signed in 1975. October was the month with the greatest number of days when streamflows were outside of this range, followed by March and then November.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Bureau of Reclamation, Projects Office, Grand Junction, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

Personal Communications

McCall, S. Bureau of Reclamation, Projects Office, Environmental Section, Grand Junction, Colorado. March 1987.

Nehring, B. Colorado Division of Wildlife Resources, Montrose, Colorado. June 1987.

References

Nehring, B. 1980. Analysis of the brown trout population dynamics in the Taylor River from 1974 through 1980 in relation to winter flow conditions. Colorado Division of Wildlife, Montrose, Colorado. Unpublished report.

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Crested Butte Mountain Resort
Colorado River System

Location	Diversion structure affects streamflows in the East River (tributary of the Gunnison River) on the Gunnison National Forest, Colorado.
Function	Snow making operations
Completion Date	1986
Operators	Crested Butte Mountain Resort
Minimum Streamflow Agreement	Crested Butte Mountain Resort entered into a Memorandum of Agreement with the U.S. Forest Service (Gunnison National Forest) on June 25, 1981. The agreement established minimum streamflows immediately below the proposed site of diversion in the East River. A FS special use permit was issued in 1985 for the construction and maintenance of the water diversion system and incorporated the 1981 Memorandum of Agreement.

Streamflow Releases	The stipulations of the FS agreement and permit are that Crested Butte can divert water as long as there is a flow of 7 cfs immediately below the diversion point in the East River. During the month of December, Crested Butte can divert water from the East River provided that a flow of 6 cfs remains in the river immediately below the point of diversion.
Objective	Maintain the fishery in the East River below the point of diversion.
Recommendations	We were unable to locate any record of involvement by the FWS. The CDWR began conducting stream surveys on the East River before Crested Butte filed for water rights for snow making operations. The CDWR determined an instream flow need of around 20 cfs, but by the time the CDWR filed for an instream flow, Crested Butte had filed for the right to divert 6 cfs of water. The United States of America (Forest Service) filed a statement of opposition against Crested Butte. Subsequently, Crested Butte entered into the above agreement with the FS as well as an agreement with the CDWR, and the United States withdrew the opposing statement. Negotiations led to an agreement for a minimum flow of 7 cfs rather than the higher flow that the CDWR had originally determined.
Streamflow Records	Crested Butte Mountain Resort installed a stream gage to monitor flows below the diversion, but we were not able to acquire any flow records.

Agency Files Providing Project Information

U.S. Forest Service, Gunnison National Forest, Gunnison, Colorado.

Personal Communications

Henry, T. Colorado Division of Wildlife Resources, Gunnison, Colorado. May 1987.

Larkin, J. Crested Butte Mountain Resort, Colorado. May 1987.

Ruff, D. U.S. Forest Service, Gunnison National Forest, Taylor River Ranger District, Gunnison, Colorado. March 1987.

Paonia Dam and Reservoir
Paonia Project
Colorado River Basin

Location	Storage dam and reservoir are located on Muddy Creek just upstream from the confluence with the Gunnison River, Gunnison County, Colorado.
Function	Water is used primarily for irrigation.
Completion Date	Paonia is part of the Colorado River Storage Project authorized by the Act of April 11, 1956 (70 Stat. 105). Construction on the dam began in 1959 and was completed in 1962.
Operators	Construction was sponsored by the BR and project operations were turned over to the North Fork Water Conservancy District in 1962. Project operations are subject to guidelines established in the BR's operating criteria for Paonia.
Minimum Streamflow Agreement	The minimum streamflow release was established in the BR's 1957 Definite Plan Report and subsequently incorporated into the BR's operating criteria.
Streamflow Releases	A minimum streamflow of 18 cfs or the natural flow, whichever is less, will be maintained below the dam during the nonirrigation season (November through March).

Objective	To maintain the downstream fishery.
Information and Methods Used	The minimum streamflow was based on historical streamflow records.
Recommendations	The FWS report on the Paonia project was not completed in time to be included in the BR's May 1957 Definite Plan Report. However, the BR operation studies were based on a minimum continuous flow of 18 cfs for fish during the nonirrigation season. When the FWS completed its report in December 1957, the recommendations did not include the 18-cfs minimum streamflow because it had already been incorporated into the project plans. The FWS did recommend that streamflow releases not be increased or decreased more than 50 percent within any one-hour period. This recommendation was accepted by the BR.
Streamflow Records	None. Apparently there have been no problems with maintaining the minimum streamflows. However, according to CDWR biologists, the stream below Paonia is very silt laden and historically has been a poor fishery.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Grand Junction, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

Personal Communications

McCall, S. Bureau of Reclamation, Environmental Section, Grand Junction, Colorado. March 1987.

Sherman, R. Colorado Division of Wildlife Resources, Montrose, Colorado. June 1987.

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Crystal Dam and Reservoir
Wayne N. Aspinall Unit (Curecanti Unit)
Colorado River Storage Project
Colorado River Basin

Location	Storage dam and reservoir are located on the Gunnison River east of Montrose, Montrose County, Colorado.
Function	Power generation

Completion Date

The Colorado River Storage Project was authorized by the Act of April 11, 1956, Public Law 485. Construction on Crystal Dam began in 1973 and was completed in 1976. Crystal Powerplant (one generating unit) operations began in 1978.

Operators

Bureau of Reclamation

Minimum Streamflow Agreement

Fish and wildlife benefits were included in the authorizing legislation for the Colorado River Storage Project, but specific minimum flows for Crystal were not established until the final environmental document was completed in 1971.

Subsequently, the minimum streamflow for the Gunnison River below Crystal Reservoir has been incorporated into the BR's operating criteria.

Streamflow Releases

Initially the minimum streamflow release from Crystal Reservoir was 200 cfs as measured below the Gunnison Tunnel. This flow release was in effect from project completion in 1976 through 1985. In November of 1985, the BR approved a higher minimum flow release of 300 cfs to be measured below the Gunnison Tunnel. This minimum flow amount has been in effect since 1986.

Objective

To maintain the downstream fishery. As studies on the Gunnison River continued in the 1980's, rainbow trout spawning habitat became the primary focus of minimum streamflow modifications.

Information and Methods Used

In 1967, the CDWR conducted fish sampling studies on the Gunnison River. Crystal Dam had not been constructed, but the Gunnison River was already impounded by two BR dams immediately upstream from the Crystal site (Morrow Point and Blue Mesa Dams). In the 1980's, the BR and CDWR conducted additional fishery studies to evaluate whether increased minimum flows would benefit the downstream fishery. CDWR applied the IFG4 method to determine necessary minimum streamflows. The studies indicated substantial habitat gains for spawning rainbow trout and other life stage requirements if the flows were increased to at least 300 cfs.

Recommendations

The FWS, with concurrence from the CDWR, opposed the construction of reservoirs on the Upper Gunnison River. The FWS stated their opposition beginning in 1951 in preliminary reports on the Curecanti Unit and Colorado River Storage Project. Thus, when the project was authorized no plans were submitted by the FWS to mitigate losses of fish and wildlife. During the preparation of the final environmental document in 1971, the CDWR expressed concern over minimum flow releases and suggested that stable flows from 200 to 800 cfs would be acceptable. The BR did not receive official recommendations from the FWS until 1978, at which time the BR had already instituted a minimum release of 200 cfs, but the FWS requested a firm commitment. Cooperation between the BR, CDWR, and FWS led to the adoption of a higher flow release in 1985.

Streamflow Records

Station: USGS located below the Gunnison Tunnel
Period of record evaluated: 1976-1986

Percent of record showing streamflow discrepancies: 2.8
Percent of record showing streamflow discrepancies greater than 10 percent: 1.1
Percent of record showing streamflow discrepancies greater than 25 percent: 0.4
Percent of record showing streamflow discrepancies greater than 50 percent: 0.1
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Low flows have occurred on some occasions due to power failures and emergency situations. During June of 1985, the BR was requested by the Montrose County Sheriff's office to reduce flows to aid search and rescue for a drowning victim. In July of 1985, flows from Crystal dropped from 1,800 cfs to 181 cfs for over an hour due to a power failure.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Projects Office, Grand Junction, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Personal Communications

McCall, S. Bureau of Reclamation, Projects Office, Grand Junction, Colorado. March 1981.

Nehring, B. Colorado Division of Wildlife Resources, Montrose, Colorado. June 1987.

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U.S. Bureau of Reclamation. [Memorandum to Projects Manager, Bureau of Reclamation, Grand Junction, Colorado]. 1985 November 8.

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U.S. Fish and Wildlife Service. 1957. A report on the fish and wildlife resources, Curecanti Unit, Colorado River Storage Project, Colorado. U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Bureau of Reclamation, Salt Lake City, Utah]. 1978 July 11.

Oso Diversion Dam
San Juan-Chama Project
Colorado River Basin

Location	Diversion dam is located on the Navajo River, near Chromo in Archuleta County, Colorado.
Function	Diverts water from the Navajo river into the Azotea Tunnel, which transports water across the Continental Divide into New Mexico. The project primarily provides water for irrigation, but also provides municipal water for Albuquerque, New Mexico.
Completion Date	The project was authorized as part of the San Juan-Chama Project by the Act of June 13, 1962. The dam was completed in 1970 and began diverting water in 1971.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	The authorizing act included a minimum flow release schedule for the Navajo River below Oso Diversion Dam. The release schedule has been incorporated into the BR's operating criteria.

Streamflow Releases

The following minimum flows or natural flow, whichever is less, were established in the 1962 authorizing legislation for Oso Diversion Dam:

October through December	37 cfs
January	30 cfs
February	34 cfs
March and April	37 cfs
May	80 cfs
June through September	55 cfs

Objective

To maintain a live stream for fish and recreation, and meet downstream water rights.

Information and Methods Used

It appears that the final flow regime was a combination of flows that had been recommended by the FWS and Colorado Department of Game and Fish (now CDWR), and a flow regime developed by the BR in 1951. The BR had formulated a flow regime in 1951 based on downstream water rights and water sufficient to maintain a live stream. The FWS and CDWR evaluated streamflow records and investigated the proposed site early in the project planning. A few years later, in 1954, the FWS conducted aquatic habitat studies. Productive and unproductive reaches were studied at different flow levels (Nelson et al. 1976).

Recommendations

In 1955 the FWS offered the following flow regime as a guideline, but not as an official recommendation, in their report on fish and wildlife resources:

October	35 cfs
November through March	30 cfs
April	40 cfs
May through August	60 cfs
September	45 cfs

According to Nelson et al. (1976), the FWS and CDWR made flow recommendations in January of 1955 that were somewhat different than the above schedule, which came out in September of 1955. We were not able to find a record of the schedule discussed by Nelson et al. (1976), but this is not unexpected since the FWS has undergone major reorganizations, and the older reports and correspondence files are much more difficult to locate now.

Streamflow Records

Station: USGS
Period of record evaluated: 1971-1985

Percent of record showing streamflow discrepancies: 26.1
Percent of record showing streamflow discrepancies greater than 10 percent: 17.5
Percent of record showing streamflow discrepancies greater than 25 percent: 7.8
Percent of record showing streamflow discrepancies greater than 50 percent: 1.9
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

We were not able to identify specific factors that might be contributing to non-maintenance. Without upstream flow records we could not assess how often the natural flow is below the minimum streamflow amounts specified in the operating criteria. Biologists with the CDWR are not aware of any major problems in maintaining streamflows below Oso and suggest that low natural flows may be the most prominent factor.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Personal Communications

Japhet, M. Colorado Division of Wildlife Resources, Durango, Colorado. October 1987.

Sherman, R. Colorado Division of Wildlife Resources, Montrose, Colorado. June 1987.

Weiler, B. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Fish and Wildlife Service. 1955. A report on fish and wildlife resources in relation to the San Juan-Chama Project. U.S. Department of Interior, Fish and Wildlife Service, Region 2, Albuquerque, New Mexico.

Blanco Diversion Dam
San Juan-Chama Project
Colorado River Basin

Location Diversion Dam is located on the Rio Blanco, tributary of the San Juan River, near Chromo in Archuleta County, Colorado.

Function Diverts water from the Rio Blanco into the Azotea Tunnel, which transports the water into New Mexico for irrigation and municipal use.

Completion Date The project was authorized by the Act of June 13, 1962. The dam was completed in 1970 and water diversions began in 1971.

Operators Bureau of Reclamation

Minimum Streamflow Agreement A minimum streamflow release schedule for the Rio Blanco below Blanco Diversion Dam was established in the 1962 authorizing legislation for the San Juan-Chama Project and subsequently incorporated into the BR's operating criteria.

Streamflow Releases The following minimum flows or the natural flow, whichever is less, are to be maintained below the diversion dam:

October and November	20 cfs
December through February	15 cfs
March and April	20 cfs
May	40 cfs
June through September	20 cfs

Objective To maintain a live stream and the fishery.

Information and Methods Used Blanco and Oso Diversion Dams are part of the San Juan-Chama Project, and investigations for both were conducted at the same time. The BR developed a minimum streamflow release schedule in 1951 based on flows needed to maintain a live stream and downstream water rights. During the FWS' preliminary investigations, streamflow records were evaluated and the proposed sites inspected. In 1954, the FWS conducted aquatic habitat studies. Productive and nonproductive stream reaches were observed at different flow levels (Nelson et al. 1976). The final flow regime was apparently a combination of flows recommended by the FWS (with cooperation from the Colorado Department of Game and Fish, now CDWR) and flows determined by the BR.

Recommendations

The FWS proposed the following minimum streamflows (or natural flow, whichever is less) in September of 1955. The flow release schedule was offered as a guideline and not an official recommendation.

October	20 cfs
November through March	15 cfs
April	25 cfs
May through August	40 cfs
September	30 cfs

According to Nelson et al. (1976), the FWS and CDWR recommended a flow regime in January of 1955 that was slightly different than the above schedule. We were not able to locate any information concerning the January 1955 recommendations as described by Nelson et al. (1976).

Streamflow Records

Station: USGS
Period of record evaluated: 1971-1985

Percent of record showing streamflow discrepancies: 18.8
Percent of record showing streamflow discrepancies greater than 10 percent: 13.0
Percent of record showing streamflow discrepancies greater than 25 percent: 7.0
Percent of record showing streamflow discrepancies greater than 50 percent: 0.2
Percent of record showing streamflow discrepancies greater than 75 percent: 0.02

Without upstream flow records we could not assess how often the flows upstream from the dam were below the minimum amounts specified in the operating criteria. Biologists with CDWR are not aware of any serious problems with maintaining streamflows, and indicated that low natural inflows may be responsible for observed discrepancies.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Personal Communications

Japhet, M. Colorado Division of Wildlife Resources, Durango, Colorado. October 1987.

Sherman, R. Colorado Division of Wildlife Resources, Montrose, Colorado. June 1987.

Weiler, B. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Fish and Wildlife Service. 1955. A report on fish and wildlife resources in relation to the San Juan-Chama Project. U.S. Department of Interior, Fish and Wildlife Service, Region 2, Albuquerque, New Mexico.

Silver Jack Dam and Reservoir
Bostwick Park Project
Colorado River Basin

Location	Storage dam and reservoir are located on Cimarron Creek, tributary to the Gunnison River, in Gunnison County near Montrose, Colorado.
Function	The project supplies water for irrigation.
Completion Date	Bostwick Park was authorized as part of the Colorado River Storage Project by Public Law 88-568 (78 Stat. 852), September 2, 1964. Construction on the dam began in 1966 and was completed in 1971.
Operators	The BR sponsored construction of the Silver Jack Dam and Reservoir. Operations were turned over to the Bostwick Park Water Conservancy District in 1976. Operations are subject to procedures defined in the BR's operating criteria.
Minimum Streamflow Agreement	Minimum streamflow releases below Silver Jack Dam were established in the BR's 1965 Definite Plan Report and subsequently have been incorporated into standard operating criteria.
Streamflow Releases	Approximately 3 miles downstream from the dam, water is diverted from Cimarron Creek via the Cimarron Ditch. Minimum streamflow releases from the reservoir are to be maintained below this diversion ditch. The minimum streamflow from May 16 through August 31 is 25 cfs, and 8 cfs the remainder of the year. The minimum flows can be reduced during low-flow periods.
Objective	To maintain aquatic habitat in Cimarron Creek. In addition, the trout fishery was expected to improve with the above releases.
Information and Methods Used	We were not able to locate any information indicating that stream surveys had been conducted. Historic streamflow records for Cimarron Creek were evaluated by the BR for their water supply studies.
Recommendations	The FWS, with cooperation from the Colorado Department of Game and Fish (now CDWR), recommended the above minimum streamflows in 1959.
Streamflow Records	The only available streamflow records for Cimarron Creek are below the dam but about 0.5 miles upstream from Cimarron Diversion Ditch. The minimum streamflows below the dam have been maintained 96 percent of the time since project completion. With out streamflow records below Cimarron Ditch we could not asses how often minimum flows were maintained farther downstream. There are no upstream flow records. Station: USGS Period of record evaluated: 1971-1986 Percent of record showing streamflow discrepancies: 3.8 Percent of record showing streamflow discrepancies greater than 10 percent: 2.9 Percent of record showing streamflow discrepancies greater than 25 percent: 1.8 Percent of record showing streamflow discrepancies greater than 50 percent: 1.5 Percent of record showing streamflow discrepancies greater than 75 percent: 0.3

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Grand Junction, Colorado.

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Personal Communications

McCall, S. Bureau of Reclamation, Environmental Section, Grand Junction, Colorado. March 1987.

Sherman, R. Colorado Division of Wildlife Resources, Montrose, Colorado. June 1987.

References

U.S. Bureau of Reclamation. 1965. Bostwick Park definite plan report. U.S. Department of Interior, Bureau of Reclamation.

U.S. Bureau of Reclamation. 1980. Bostwick Park project. U.S. Government Printing Office.

U.S. Fish and Wildlife Service. [Letter to Regional Director, Region 4, Bureau of Reclamation]. 1959 July 10.

Lemon Dam and Reservoir
Florida Project
Colorado River Basin

Location	Storage dam and reservoir are located on the Florida River near Durango in La Plata County, Colorado.
Function	Florida Project primarily supplies water for irrigation.
Completion Date	Florida Project was authorized as a part of the Colorado River Storage Project by the Act of April 11, 1956 (70 Stat. 105). Construction on the dam began in 1961 and was completed in 1963.
Operators	The BR sponsored construction of the project and turned over operations to the Florida Water Conservancy District in 1968. The dam and reservoir are subject to operating criteria determined by the BR.
Minimum Streamflow Agreement	A minimum streamflow below Lemon Dam was established in the BR's 1959 Definite Plan Report and subsequently was incorporated into the operating criteria.
Streamflow Releases	The minimum streamflow release below Lemon Dam is 4 cfs during the nonirrigation season (October 16 through April 30). According to Nelson et al. (1976), the minimum streamflow release accepted by the BR was 10 cfs at the dam and 4 cfs below a diversion ditch located about 4.5 miles downstream from the dam. We were not able to locate any information confirming this, and according to the BR in Durango, Colorado, the minimum release at the dam is 4 cfs and not 10. Going back to the 1959 Definite Plan Report, the minimum release is specifically stated: "during the nonirrigation season a minimum flow of 4 second-feet will be maintained below the reservoir as recommended by the Bureau of Sport Fisheries and Wildlife."
Objective	To maintain the downstream fishery.
Information and Methods Used	Streamflow records were examined and a field survey was conducted by the FWS in 1957. The proposed site was visually examined and fish habitat identified, but apparently no systematic sampling was conducted.

Recommendations

The FWS did not officially recommend a minimum streamflow in any of its reports or in the 1959 FWCA report. The FWS's 1959 FWCA report described streamflows below the reservoir as follows:

> "Although winter fishery releases from the dam will average 10 second-feet, the city of Durango diversion located 4.5 miles downstream from the dam will reduce this flow to 4 second-feet at times."

Information in the BR's Definite Plan Report indicates that the BR received a recommendation of 4 cfs from the FWS at some time. It is possible that the FWS made a verbal recommendation to the BR that was not reflected in any of their reports.

Streamflow Records

Station: BR records of water releases from Lemon Reservoir
Period of record evaluated: 1965-April 1987

Percent of record showing streamflow discrepancies: 1.5
Percent of record showing streamflow discrepancies greater than 10 percent: 1.5
Percent of record showing streamflow discrepancies greater than 25 percent: 1.2
Percent of record showing streamflow discrepancies greater than 50 percent: 1.1
Percent of record showing streamflow discrepancies greater than 75 percent: 1.1

Flow records upstream from the reservoir are not available, nor are there flow records below the City of Durango's diversion ditch. Thus, we were not able to evaluate how often upstream flows are lower than 4 cfs or whether the 4 cfs is maintained below the diversion ditch.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Westside Colorado Projects Office, Durango, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Personal Communications

Moomaw, D. Bureau of Reclamation, Westside Colorado Projects Office, Environmental Section, Durango, Colorado. March 1987.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Bureau of Reclamation. 1959. Florida Project, Colorado definite plan report, November 1959. U.S. Department of Interior, Bureau of Reclamation, Region 4, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 1982. Florida Project. U.S. Government Printing Office.

U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1959 June 16.

U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1966 June 17.

McPhee Dam and Reservoir
Dolores Project
Colorado River Basin

Location	Storage dam and reservoir are located on the Dolores River in Montezuma County, Colorado.
Function	McPhee Dam and Reservoir is a multi-purpose facility developing water for irrigation, municipal and industrial supply, recreation, fish and wildlife, and power generation.
Completion Date	Construction on the dam was completed in 1985, and the reservoir was expected to finish filling in 1987. Irrigation facilities were not completed as of 1987.
Operators	Presently, the Bureau of Reclamation is responsible for the project. Eventually, operations will be turned over to the Dolores Water Conservancy District.
Minimum Streamflow Agreement	Provisions for minimum streamflow releases from McPhee Reservoir are established in the BR's operating criteria. Minimum streamflows were accepted by the BR following recommendations from the FWS and CDWR in 1976.
Streamflow Releases	The minimum streamflow releases from McPhee Reservoir are: 20 cfs during dry years, 50 cfs during normal runoff years, and 78 cfs during wet or above average runoff years, or the natural inflow to the reservoir, whichever is less.
Objective	To maintain and help reestablish a trout fishery. The species of primary interest is brown trout.
Information and Methods Used	In 1972, a preliminary field investigation of the dam and reservoir site was conducted by the FWS, CDWR, BR, and several other interested parties. The CDWR conducted stream surveys and hydraulic studies in October and November of 1973 and March of 1974. Fish populations were surveyed by electrofishing and gill netting. Stream profiles that included stream width, depth, and wetted perimeter were determined at three survey stations. Water temperature and chemistry data were also collected. The results of this survey led to recommendations for a minimum flow of 78 cfs. The CDWR conducted an additional field survey in August of 1974. This survey substantiated the 78-cfs minimum flow, and indicated that a flow of 50 cfs would cover 50 percent of the wetted perimeter.
Recommendations	In 1961, the FWS submitted recommendations to the BR under the FWCA for a minimum streamflow release of 50 cfs May 15 through October 31 and 35 cfs during the rest of the year. Apparently, this recommendation was based on historic streamflow information. Following the 1974 studies, the CDWR recommended a minimum flow of 78 cfs. The BR responded by stating that a release of 78 cfs would impose some serious constraints on project operations. The BR suggested that 78 cfs could be maintained in wet years and that minimum flows would have to be reduced to 20 cfs during dry periods when other water users would also be experiencing shortages. In 1976, the FWS recommended a minimum instantaneous release of 50 cfs to maintain the fishery, increasing to 78 cfs whenever possible, and 20 cfs during extreme drought periods.
Streamflow Records	Station: BR records for releases from McPhee Reservoir Period of record evaluated: 1985-April 1987 Percent of record showing streamflow discrepancies: 1.6 Percent of record showing streamflow discrepancies greater than 10 percent: 0.0 Minimum flows of 50 cfs (representing normal operations) have been maintained over 98 percent of the time since the dam was completed in 1985. Flows have always been greater

than 20 cfs, and flows of at least 78 cfs have been maintained about 66 percent of the time.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Grand Junction, Colorado.

Personal Communications

Kjar, C. Bureau of Reclamation, Westside Projects Office, Durango, Colorado. May 1987.

Moomaw, D. Bureau of Reclamation, Environmental Section, Westside Projects Office, Durango, Colorado. March 1987.

Smith, D. Colorado Division of Wildlife Resources, Denver, Colorado. April 1987.

References

Colorado Water Conservation Board. [Letter to Project Manager, Bureau of Reclamation, Grand Junction, Colorado]. 1975 April 7.

U.S. Bureau of Reclamation. [Letter to Colorado Water Conservation Board, Denver, Colorado]. 1975 April 18.

U.S. Bureau of Reclamation. 1983. Dolores Project. U.S. Government Printing Office.

U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Bureau of Reclamation, Region 4, Salt Lake City, Utah]. 1961 September 29.

U.S. Fish and Wildlife Service, Regional Director. [Memorandum to Area Manager, Fish and Wildlife Service, Salt Lake City, Utah]. 1976 March 2.

Lower Urad Reservoir
Lower Missouri River Basin

Location	Storage dam and reservoir are located on Woods Creek, near Georgetown in Clear Creek County, Colorado.
Function	Industrial: Supplies water for mining and milling operations.
Completion Date	1967
Operators	American Metal Climax Inc. and the City of Golden, Colorado
Minimum Streamflow Agreement	A minimum streamflow was established in the BLM right-of-way permit issued May 26, 1965.
Streamflow Releases	The operators are required to bypass a minimum streamflow of 3 cfs or the natural flow, whichever is less, into Woods Creek below the dam.
Objective	To maintain water quality in Woods Creek. Water from the mining operation enters Upper Urad Reservoir, which acts as a settling pond, then flows into Lower Urad and finally into Woods Creek. In order to insure that water quality is protected, the operators divert water above the reservoirs to provide an uncontaminated bypass minimum flow of 3 cfs.

Information and Methods Used	The minimum streamflow was based on a joint field investigation by the FWS and Colorado Department of Game, Fish and Parks (now CDWR) in 1964.
Recommendations	The FWS reviewed the proposed project and in 1965 recommended to BLM that a minimum bypass flow of 3 cfs or the natural flow, whichever is less, be included in the right-of-way permit.
Streamflow Records	None

References

Horak, G. 1978. Instream flow agreements on privately operated projects. Enviro Control Inc., Fort Collins, Colorado. Unpublished report.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Georgetown Lake and Dam
Lower Missouri River Basin

Location	Storage dam and reservoir are located on Clear Creek near Georgetown, Clear Creek County, Colorado.
Function	Recreation
Completion Date	1973
Operators	City of Georgetown, Colorado
Minimum Streamflow Agreement	The City of Georgetown filed an application under the Recreation and Public Purposes Act (44 Stat. 401, as amended; 16 U.S.C. 661) to obtain lands for construction of the dam and lake. The proposed site consisted of lands under the jurisdiction of BLM, and a BLM lease, including conditions for minimum streamflows, was issued for the project in June 1969. In addition, the minimum streamflow was included as an Addendum (between Colorado Division of Game, Fish and Parks and the City of Georgetown) to the Contract for Construction.
Streamflow Releases	A minimum streamflow of 20 cfs or the inflow to Georgetown Lake, whichever is less, must be bypassed to Clear Creek below the dam at all times.
Objective	To protect fish habitat in Clear Creek.
Information and Methods Used	According to Nelson et al. (1976), the minimum streamflow was based on a joint field investigation of the proposed site by the Bureau of Outdoor Recreation, FWS, and BLM.
Recommendations	The FWS reviewed the proposed project and application for a BLM lease and recommended a minimum flow of 20 cfs, or the inflow, in Clear Creek below the dam. The Colorado Division of Game, Fish and Parks concurred in a letter dated April 21, 1969.
Streamflow Records	Station: USGS Period of record evaluated: 1974-1985 Percent of record showing streamflow discrepancies: 0.1

Percent of record showing streamflow discrepancies greater than 10 percent: 0.0

According to streamflow records below the dam, the flow in Clear Creek has fallen below 20 cfs on only four days since water year 1974.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Colorado Division of Game, Fish and Parks. [Letter to Bureau of Sport Fisheries, Albuquerque, New Mexico]. 1969 April 21.

U.S. Fish and Wildlife Service, Albuquerque, New Mexico. [Letter to State Director, Bureau of Land Management, Denver, Colorado]. 1969 May 12.

Strontia Springs Diversion Dam
Foothills Project
Lower Missouri River Basin

Location	Strontia Springs Dam is located on the South Platte River south of Denver in Douglas County, Colorado.
Function	The dam diverts water from the South Platte River into the Foothills Tunnel, which transports water to the Foothills Water Treatment Plant. The facility treats water from the South Platte for use in the Denver Water System.
Completion Date	The dam was completed in 1982.
Operators	The Denver Water Board
Minimum Streamflow Agreement	A BLM right-of-way was issued to the Denver Water Board (DWB) in 1967 for the construction of the Foothills Project. The permit allowed five years for construction, but due to design changes the DWB applied for an extension in 1973. BLM granted the extension, but with the enactment of NEPA an environmental assessment was required. The DWB submitted an Environmental Impact Assessment in April 1974. That same year the DWB applied for another extension. The BLM stated that it (the Federal Government) needed to prepare an environmental impact statement before the extension could be granted. BLM prepared the Draft Environmental Statement (DES) and submitted it to the Department of Interior Solicitor, who found it to be insufficient. A second DES was completed in 1977 and the Final ES was completed in 1978. Meanwhile, the DWB filed suit against the Departments of Interior and Agriculture for delaying decisions on issuing BLM, FS, and other permits necessary for the construction of the Foothills Project. In 1978 the BLM decided to approve the right-of-way application with a water conservation stipulation. In 1979 the DWB, City and County of Denver, State of Colorado, Colorado Water Conservation Board, and Colorado Division of Parks and Outdoor Recreation signed the

Water Management Plan for the South Platte River Canyon Below Strontia Springs Dam. The agreement establishes minimum streamflows in the South Platte below Strontia Springs. The agreement was submitted to BLM and the FS to satisfy stipulations in permits issued by the agencies. In addition, the agreement became part of the COE 404 permit for the project.

Streamflow Releases

The agreement establishes minimum flows in the South Platte River below Strontia Springs Dam of 60 cfs May 15 through September 15 and 30 cfs from September 16 through May 14. There are exceptions to these flows including that the DWB can divert, between September 16 and May 14, up to 15 cfs of the 30 cfs if the management for available storage in Chatfield Reservoir requires such diversions. DWB can also reduce the bypass flows during drought conditions and operational emergencies upon approval from BLM and the FS.

Objective

To preserve the downstream fishery and aquatic habitat.

Information and Methods Used

Because of the controversy involved in the construction of Strontia Springs Dam, studies were conducted by the DWB, FWS, BLM, and CDWR. The DWB applied several instream flow methodologies, which included the Tennant method and the Q7-10 (7-day, 10-year low flow) method in order to compare minimum streamflow estimates. The CDWR applied the R-2 Cross method and conducted extensive fish population surveys. In the late 1970's, the FWS conducted an IFIM analysis.

Recommendations

The FWS reviewed the DWB application for a BLM right-of-way in 1964 and recommended (with agreement from the CDWR) that the BLM require minimum bypass of 60 cfs at all times except during water shortages, operating emergencies, or when the total downstream requirements are less than 60 cfs, and that the DWB in these situations bypass 20 cfs or the natural inflow, whichever is less.

When the DWB changed the original design and applied for a second extension to the BLM right-of-way, the FWS (with agreement from the CDWR) recommended that the right-of-way for the project be denied. Thus, BLM denied the permit until environmental assessments were completed, and at the same time the DWB filed suit against the Department of Interior. The recommended flows of 60 cfs and 30 cfs resulted from the studies conducted by the CDWR and FWS during the preparation of the environmental statements and ensuing negotiations.

Streamflow Records

Station: USGS
Period of record evaluated: 1983-1985

Percent of record showing streamflow discrepancies: 5.9
Percent of record showing streamflow discrepancies greater than 10 percent: 5.7
Percent of record showing streamflow discrepancies greater than 25 percent: 4.4
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

The USGS gage is located downstream from the Last Chance Ditch where the DWB can divert up to 15 cfs of the 30 cfs bypass flow during the period of September 16 - May 14. Thus, in order to evaluate maintenance of minimum flows we considered flow levels of 60 cfs May 15 through September 15, and 15 cfs (30 cfs minus the 15 cfs that DWB can divert) the remainder of the water year. Since the dam was completed in 1982, these minimum flows have been maintained about 94 percent of the time. Without upstream flow data, it is not possible to evaluate how often inflows to the project are below the minimum bypass amounts.

Agency Files Providing Project Information

Colorado Division of Wildlife Resources, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Lakewood, Colorado.

Personal Communications

Helbig, V. Retired, U.S. Fish and Wildlife Service, Denver, Colorado. October 1987.

Knox, R. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

Kochman, E. Colorado Division of Wildlife Resources, Denver, Colorado. October 1987.

Taylor, B. Denver Water Board, Environmental Section, Denver, Colorado. July 1987.

References

Denver Water Department. 1976. Features of the Denver Water System. Office of Public Affairs, Denver Water Department, Denver, Colorado.

U.S. Bureau of Land Management. 1978. Program option document, Foothills Project (as proposed by the Denver Water Board). U.S. Department of Interior, Bureau of Land Management. Unpublished report.

U.S. Fish and Wildlife Service. [Memorandum to State Director, Colorado State Office, Bureau of Land Management, Denver, Colorado]. 1964 January 24.

U.S. Fish and Wildlife Service. [Memorandum to State Director, Bureau of Land Management, Denver, Colorado]. 1975 August 20.

U.S. Fish and Wildlife Service. [Memorandum to Director, Bureau of Land Management, Denver, Colorado]. 1977 September 29.

South Platte Diversion
Lower Missouri River Basin

Location	Diversion dam is located on the South Platte River about 20 miles southwest of Denver, Jefferson and Douglas Counties, Colorado.
Function	The diversion dam is part of the City of Aurora's Homestake Water Diversion System to provide water for municipal use. The dam diverts water from the South Platte into a tunnel that conveys the water to the Aurora-Rampart Reservoir.
Completion Date	1967
Operators	City of Aurora
Minimum Streamflow Agreement	A BLM right-of-way permit was granted on March 10, 1966. The right-of-way established a minimum streamflow in the South Platte below the diversion dam.
Streamflow Releases	The operators are required to maintain a minimum instantaneous flow of 60 cfs below the dam at all times.
Objective	To maintain the downstream fishery and aquatic habitat.
Information and Methods Used	A joint field investigation of the proposed site was conducted by the FWS and Colorado Department of Game, Fish and Parks (now CDWR). The minimum streamflow was based on the field investigation, streamflow records, and professional judgment.

Recommendations	According to Nelson et al. (1976), in 1963 the FWS and Colorado Department of Game, Fish and Parks officially recommended a minimum streamflow below the dam of 60 cfs at all times.
Streamflow Records	There is a USGS gage upstream from the South Platte Diversion Dam, but downstream data are not available.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

U.S. Fish and Wildlife Service, Albuquerque, New Mexico. [Letter to Regional Director, Bureau of Reclamation, Denver, Colorado]. 1959 July 17.

Harold D. Roberts Tunnel
Lower Missouri River Basin

Location	The west portal of the tunnel is located at the base of Dillon Reservoir, near Dillon, Colorado on the west side of the Continental Divide. The tunnel conveys water to the east across the divide, with the east portal located on the North Fork South Platte River near Grant in Park County, Colorado.
Function	The tunnel conveys water from Dillon Reservoir (Blue River System) into the South Platte River System for municipal use by the City and County of Denver.
Completion Date	1962
Operators	Denver Water Board
Minimum Streamflow Agreement	According to Nelson et al. (1976), the existing BLM permit for the project was issued in October 1963 and amended in May 1970 to include a minimum streamflow at the east portal of the tunnel.
Streamflow Releases	The BLM permit recommends that a minimum streamflow of 100 cfs be maintained in the North Fork South Platte River at the east portal of the tunnel. According to Denver Water Board representatives, there is no required minimum streamflow at the east portal of the tunnel. The difference in interpretations is apparently due to the wording of the minimum flow condition in the BLM permit. The BLM permit recommends a minimum flow in the North Fork South Platte at the east portal, but only when consistent with the normal operations of the Denver Water Board. The language of the BLM permit is not binding and has rendered the minimum streamflow requirement useless.
Objective	To preserve aquatic habitat in the North Fork of the South Platte River. Since the project was completed in 1962, the channel of the North Fork had been enlarged to accommodate water being conveyed through the tunnel. The minimum flow recommendations were made in light of the enlarged channel capacity.

Information and Methods Used

Apparently the FWS, FS, Colorado Division of Game, Fish and Parks (now CDWR), BLM, and the Denver Water Board were involved in determining the minimum streamflow. The flow amount was based on the capacity of the enlarged North Fork channel, professional judgment, and negotiations.

Recommendations

In 1970, the FWS officially recommended that a minimum streamflow of 100 cfs be maintained in the North Fork South Platte River at the east portal of the tunnel.

Streamflow Records

Streamflow records at the east portal were obtained from the State of Colorado Engineers Office, but the data were not included in our streamflow analyses because of the manner in which the Denver Water Board has been operating the tunnel and how the streamflow data are recorded. The State Engineers Office only has flow data for those periods when the Denver Water Board is transporting water through the tunnel. There is a USGS gage farther downstream, but it includes flows from Geneva Creek, which comes into the North Fork below the tunnel. What is evident from the State Engineers flow records is that the Denver Water Board does not operate the tunnel on a regular basis. Since 1983, the tunnel has been used to transport water from Dillon Reservoir less than 50 days, and on only 18 days was the flow coming out of the tunnel greater than 100 cfs. According to Denver Water Board representatives, they have not needed to use the tunnel or water is not available in Dillon Reservoir to transport.

Personal Communications

Taylor, B. Denver Water Board, Environmental Section, Denver, Colorado. July 1987.

References

Denver Water Department. 1976. Features of the Denver water system. Office of Public Affairs, Denver Water Department, Denver, Colorado.

Horak, G. 1978. Instream flow agreements on privately operated projects. Enviro Control Inc., Fort Collins, Colorado. Unpublished report.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

FACT SHEETS FOR MONTANA

Painted Rocks Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the West Fork of the Bitterroot River, Ravalli County, Montana.
Function	Painted Rocks was constructed as a multi-purpose project, but primarily supplies irrigation water.
Completion Date	1940
Operators	Montana Department of Natural Resources and Conservation (DNRC)
Minimum Streamflow Agreement	The MDFWP purchased 5,000 acre-feet of available water from the DNRC in 1957 to be released for fishery purposes. In 1983 an additional 10,000 acre-feet of water were purchased from DNRC to augment fishery flows. Water purchase contracts and the Northwest Power Planning Council's "Fish and Wildlife Program" (pursuant to the Pacific Northwest Electric Power Planning and Conservation Act of 1980) establish the amount of water to be used for maintenance of fishery flows.
Streamflow Releases	Even though MDFWP purchased water beginning in 1957, there was no specific release schedule. In 1984, MDFWP proposed a draft release schedule for the 15,000 acre-feet that would maintain flows of 375 cfs July through September in the Bitterroot River at Bell Crossing (more than 50 miles downstream from Painted Rocks). From 1983 through 1987, about 15,000 acre-feet were released each summer. MDFWP conducted stream studies during this time, and in 1987 the release schedule was modified to maximize the amount of time a flow of 402 cfs could be maintained at Bell Crossing. Releases from the reservoir of 50 cfs July 16 through 31 are estimated to provide a minimum flow of 402 cfs at Bell Crossing 94 percent of the time. Releases of 112 cfs during August and 110 cfs in September are expected to maintain 402 cfs at Bell Crossing 47 and 45 percent of the time, respectively.
Objective	To augment summer streamflows for the trout fishery (brown and rainbow trout) in the Bitterroot River downstream to Bell Crossing.
Information and Methods Used	The minimum flow of 375 cfs at Bell Crossing was based on historical streamflow records. The MDFWP began stream studies (funded by the Bonneville Power Administration pursuant to the Power Planning Act of 1980) in 1983 on the Bitterroot River downstream from Painted Rocks Dam and Reservoir. Electrofishing surveys were conducted to estimate fish populations, and the wetted perimeter inflection point method (WETP) was used to determine the minimum flow recommendation of 402 cfs at Bell Crossing.
Recommendations	The FWS has not been involved in determining minimum streamflows below Painted Rocks.
Streamflow Records	According to MDFWP biologists, water releases from Painted Rocks Reservoir have never been a problem as much as maintaining the water in the river farther downstream. The reach of the Bitterroot River upstream from Hamilton down to almost Stevensville (over 20 miles) has historically been severely dewatered during the irrigation season. Thus,

the objective has been to maintain water in this reach of river. A USGS gage was installed at Bell Crossing in October 1986, but daily streamflow data will not be available until the end of 1987. There is a USGS gage immediately downstream from the reservoir, but since the purpose of the agreement is to maintain flows in the Bitterroot River, and there have not been any problems with flows immediately below the reservoir, we did not feel it was appropriate to evaluate data from this station.

Personal Communications

Fry, S. Montana Department of Natural Resources and Conservation, Billings, Montana. June 1987.

Workman, D. Montana Department of Fish, Wildlife and Parks, Missoula, Montana. July 1987.

References

Northwest Power Planning Council. 1984. Columbia River basin fish and wildlife program. Northwest Power Planning Council, Portland, Oregon.

Spoon, R. 1987. Evaluation of management of water releases for Painted Rocks Reservoir, Bitterroot River, Montana. Montana Department of Fish, Wildlife and Parks, Missoula, Montana.

Libby Dam and Reservoir (Lake Kookanousa)
Upper Columbia River Basin

Location	Storage dam and reservoir are located on the Kootenai River, approximately 17 miles south of Libby in Lincoln County, Montana.
Function	Power production and flood control are the primary uses.
Completion Date	The project was authorized by the Flood Control Act of 1950. The first storage of water was in 1972 and the dam was completed a year later in July of 1973. Libby is a five-unit power generating facility. The first and second units became operational in 1975, the third and fourth in 1976, and the fifth unit went on line in 1984.
Operators	U.S. Army Corps of Engineers
Minimum Streamflow Agreement	The Corps of Engineers' "Water Control Manual for the Libby Project" sets guidelines for minimum streamflow releases. A minimum release has been in effect since the project was completed. Soon after the project was completed two additional target flows were identified and incorporated into the operating manual. In 1980, the Northwest Electric Power Planning and Conservation Act was passed (16 U.S.C. 839). The Act directed the Northwest Power Planning Council (NPPC) to develop a program to protect, mitigate, and enhance fish and wildlife resources on the Columbia River system. The NPPC directed the Corps to ensure flows below Libby that would protect the resident fish in the Kootenai River. The flow releases established in the operating manual (through negotiations between the COE and MDFWP) are reiterated in the NPPC's "Columbia River Basin Fish and Wildlife Program."
Streamflow Releases	There are three target flow releases from Libby. Under normal conditions the COE tries to maintain a minimum flow of 4,000 cfs as often as possible. To assure that the reservoir refills, during May, June, and the first part of July releases can be reduced to 3,000 cfs. There is a minimum discharge of 2,000 cfs, which is supposed to be released only during emergency situations. The 2,000 cfs has been effective since the project became operational. Through negotiations the 3,000- and 4,000-cfs releases were adopted by the Corps in the late 1970's.

The target flows of 3,000 and 4,000 cfs are discussed in the NPPC's Fish and Wildlife Program. According to MDFWP sources, these will be the final flow recommendations to the NPPC in 1988 (or when the reservoir studies are completed) along with more definite terms regarding conditions under which the flows can be reduced. In addition, the final flow recommendations will have to be compatible with recommendations for the reservoir fishery.

Objective

To protect and maintain downstream aquatic resources.

Information and Methods Used

There was very little information on the aquatic resources prior to the construction of Libby Dam. The first minimum streamflow recommendation (for 2,500 cfs), offered by the FWS with agreement from MDFWP and Idaho Fish and Game, was based on 40 years of streamflow records. The releases presently in effect were determined before most of the studies were conducted or completed, and were based on streamflow records, professional judgement, project operations, and negotiations.

The COE funded a comprehensive biological study of the Kootenai, and data were collected by MDFWP from 1972 to 1982. The results of this study supported a minimum flow of 4,000 as long as winter flows remained higher. However, a flow of 5,000 cfs was determined to provide more wetted surface area. This information will be used to support the MDFWP's final recommendations to the NPPC.

Recommendations

In 1965, the FWS, with agreement from MDFWP, recommended a minimum instantaneous release of 2,500 cfs from Libby Reservoir. This recommendation was not incorporated into the COE's Water Control Manual. Evidently 2,000 cfs is the minimum flow required to run the generating units at speed-no-load. The MDFWP was primarily involved in negotiating the higher releases of 3,000 and 4,000 cfs soon after the project was completed.
Since the completion of the downstream studies by MDFWP, a flow of 5,000 cfs has been determined to provide more adequate fishery conditions. However, the target flows remain at 2,000, 3,000, and 4,000 cfs. The MDFWP is continuing negotiations with the COE. The goal of the negotiations is to specify what constitutes an emergency situation and a low-water year so that 4,000 cfs can be maintained as often as possible, and to reduce flow fluctuation rates.

Streamflow Records

Station: USGS 0.7 miles below Libby Dam
Period of record evaluated: 1972-1986

2,000-cfs release
Percent of record showing streamflow discrepancies: 0.02
Percent of record showing streamflow discrepancies greater than 10 percent: 0.0

3,000-cfs release
Percent of record showing streamflow discrepancies: 7.4
Percent of records showing discrepancies greater than 10 percent: 3.2
Percent of records showing discrepancies greater than 25 percent: 0.7
Percent of records showing discrepancies greater than 50 percent: 0.0

4,000-cfs release
Percent of records showing discrepancies: 24.4
Percent of records showing discrepancies greater than 10 percent: 17.6
Percent of records showing discrepancies greater than 25 percent: 7.4
Percent of records showing discrepancies greater than 50 percent: 0.02
Percent of records showing discrepancies greater than 75 percent: 0.0

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.

Personal Communications

Houston, J. Montana Department of Fish, Wildlife and Parks, Kalispell, Wyoming. June 1987.

May, B. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana. October 1987.

References

Montana Department of Fish, Wildlife and Parks. 1983. Kootenai River fisheries investigations, final completion report. Sponsored by U.S. Army Corps of Engineers, prepared by Montana Department of Fish, Wildlife and Parks.

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U.S. Army Corps of Engineers. 1984. Water Control Manual, Libby Dam and Lake Kookanousa, Kootenai River, Montana. Corps of Engineers, Seattle, Washington.

U.S. Fish and Wildlife Service. 1965. A detailed report on fish and wildlife resources affected by Libby Dam and Reservoir project, Kootenai River, Montana. U.S. Department of Interior, Fish and Wildlife Service, Portland, Oregon.

Kerr Hydroelectric Project
Columbia River Basin

Location	Kerr hydroelectric project is located at Kerr Dam on the Flathead River, Flathead and Lake Counties, Montana. The project is located on the Flathead Indian Reservation and Federal, nontribal lands.
Function	Kerr is a three-unit hydroelectric project.
Completion Date	Kerr Dam and the first generating unit were operational in 1938. The second and third generating units became operational in 1949 and 1954, respectively.
Operators	Rocky Mountain Power Company was the original licensee. Operations were turned over to Montana Power Company (MPC) in 1938. In 1976 MPC applied to renew its operating license and the Confederated Salish and Kootenai Tribes filed a competing license. A settlement was arrived at in 1985, and a FERC license for the operation of the Kerr Project was issued jointly to MPC and the Confederated Salish and Kootenai Tribes. MPC is responsible for operating the project for 30 years, after which the Tribes will take over operations.
Minimum Streamflow Agreement	The minimum streamflow releases below the Kerr Project are specified in the 1985 FERC license for the project. A license was originally issued for the project in 1930 by the Federal Power Commission (now FERC). The original license expired in 1980, at which time MPC filed for renewal. Annual licenses were issued until the project could be reviewed by fish and wildlife agencies, and a settlement was reached between MPC and the Tribes.
Streamflow Releases	Article 44 of the 1985 FERC license specifies that:

> "Licensee shall maintain a continuous minimum outflow of 3,200 cfs, as measured immediately downstream from the project powerhouse, provided that at times during the period between July 1 and September 15 when the elevation of Flathead Lake is below 2892.7 feet, the outflow may be reduced below 3,200 cfs to a rate equal to

the greater of (i) the average of the past 15 days' deduced inflow into the Lake, or (ii) 2,200 cfs."

Article 44 allows flows to be reduced up to two hours during operating emergencies.

Objective

Maintenance of aquatic habitat in the Flathead River downstream from Kerr Dam.

Information and Methods Used

By December of 1980, FWS biologists had begun preliminary investigations on the Flathead River below Kerr. Channel morphology data were collected and the HEC-2 program, or water surface profile method, was used to make initial minimum streamflow recommendations. By March of 1982, more comprehensive studies had been conducted by the FWS and representatives from MPC and the Salish and Kootenai Tribes. Stream transects were established to measure the wetted width at discharges of 2,000, 4,000, 6,000, and 10,000 cfs. Channel profile and rate of change in surface elevation data were also collected. Biological data were also collected to evaluate invertebrate production. Information from the 1980 and 1982 studies was used to determine the final recommended minimum flows.

Currently, the Bonneville Power Administration, under the Pacific Northwest Electric Power Planning and Conservation Act of 1980, is funding studies to evaluate effects of river fluctuations from the operations at Kerr Dam on the downstream fishery. The FWS's IFIM methodology has been applied for these studies, but the estimates derived were not used to negotiate the minimum flows for the FERC license.

Recommendations

After the 1980 study, the FWS made a tentative recommendation of a 3,000-cfs minimum instantaneous discharge for all months except June. A flow of 12,000 cfs was recommended during June to flood side channels and wetland areas, as well as flush fines from the substrate. With additional information provided by the study completed in 1982, the FWS revised its recommendation upward to 3,200 cfs during all months except June, and 12,000-cfs discharge during June to flood side channels and wetland areas.

Streamflow Records

Streamflow records from a USGS gage below Kerr Dam were evaluated to determine if 3,200 cfs had been maintained since the relicensing in 1985. FERC has been inspecting the Kerr Project on an annual basis. According to their 1986 inspection report, the minimum streamflow conditions of the FERC license have been met.

Station: USGS
Period of record evaluated: 1985-1986

Percent of record showing minimum streamflow discrepancies: 0

Agency Files Providing Project Information

Federal Energy Regulatory Commission, Portland, Oregon.

Federal Energy Regulatory Commission, Washington, D.C.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Personal Communications

Sprague, D. Montana Power Company, Butte, Montana. October 1987.

Darling, J. Montana Department of Fish, Wildlife and Parks, Billings, Montana. June 1987.

References

Federal Energy Regulatory Commission. Order approving settlement and issuing license, Montana Power Company and the Confederated Salish and Kootenai Tribes of the Flathead Reservation, Project No. 5. Issued July 17, 1985.

Steucke, W. U.S. Fish and Wildlife Service, Billings Area Office. [Letter to Montana Power Company, Butte, Montana and Confederated Salish and Kootenai Tribes, Pablo, Montana]. March 10, 1982.

Steucke, W. U.S. Fish and Wildlife Service, Billings Area Office. [Letter to Federal Energy Regulatory Commission, Washington, D.C.]. June 9, 1982.

U.S. Department of the Interior, Office of the Secretary. [Letter to Federal Energy Regulatory Commission, Washington, D.C.]. December 9, 1980.

Wood, J. U.S. Fish and Wildlife Service, Billings Area Office. [Letter to Federal Energy Regulatory Commission, Washington D.C.]. July 8, 1982.

Big Fork Hydroelectric Project
Columbia River Basin

Location	The diversion dam is located on the Swan River near Kalispell in Flathead County, Montana.
Function	Power generation
Completion Date	The project was constructed in 1902 and enlarged in 1928 to its present capacity of 4,150 KW. The project was licensed by FERC in 1976.
Operators	The original operator was Big Fork Electric Company. In 1909 the project was sold to Northern Idaho and Montana Power Company. A transfer was made to Montana States Power Company in 1918, which merged in 1954 with the present operator, Pacific Power and Light Company.
Minimum Streamflow Agreement	Minimum streamflows were established in Exhibit S of FERC license No. 2652. The license was issued in 1976, but Exhibit S was not approved until March 12, 1978.
Streamflow Releases	Article 24 of the FERC license states that Pacific Power Company should release an adequate amount of water to protect and develop the aquatic habitat. Exhibit S requires a year-round minimum streamflow of 40 cfs below the project. Before the approval of Exhibit S in 1978, the licensee maintained about 25 cfs, but this was not an official minimum streamflow release. The required streamflows are restated in the Columbia River Basin Fish and Wildlife Program (coordinated by the Northwest Power Planning Council pursuant to the Pacific Northwest Electric Power Planning and Conservation Act of 1980).
Objective	According to the FERC license, the objectives are to protect and develop the aquatic habitat and maintain fish habitat.
Information and Methods Used	Information from agency files and biologists with the MDFWP and Pacific Power indicates that the minimum streamflow amount was the result of professional opinion and negotiations between the power company and MDFWP.
Recommendations	Licensing of the Big Fork Project was initiated in the late 1960's. At this time both the FWS and MDFWP recommended that adequate flows be released from the diversion dam to maintain the downstream fishery. According to the FERC license, MDFWP recommended a minimum flow of 40 cfs in a letter dated October 20, 1967. From information contained

in FWS correspondence files, it appears that the FWS concurred with minimum flows that were determined by MDFWP.

Streamflow Records	None
	According to Pacific Power and Light representatives, there have been no problems in maintaining the 40-cfs minimum flow release. Streamflows are released through a debris sluice in the dam and stop logs are added or removed as necessary. Power company representatives have stated that even during low-water years, maintenance of the 40 cfs should not be a problem.

Agency Files Providing Project Information

Federal Energy Regulatory Commission, Portland, Oregon.

Federal Energy Regulatory Commission, Washington, D.C.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Personal Communications

Eddy, B. Pacific Power and Light Company, Aquatic Biology Section, Portland, Oregon. October 1987.

Fraley, J. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana. October 1987.

References

deSousa, S. Pacific Power and Light Company. [Letter to Federal Energy Regulatory Commission, Portland, Oregon]. January 14, 1986.

Eddy, B. Pacific Power and Light Company, Portland, Oregon. [Letter to U.S. Fish and Wildlife Service, Billings, Montana]. April 1, 1986.

Federal Energy Regulatory Commission. Order approving Exhibit S, Project No. 2652. Issued March 14, 1978.

Federal Power Commission. Order issuing license (major), Project No. 2652. Issued September 24, 1976.

Northwest Power Planning Council. 1984. Columbia River basin fish and wildlife program. Northwest Power Planning Council, Portland, Oregon.

Woodgerd, W. Montana Department of Fish and Game, Helena, Montana. [Letter to Federal Power Commission, Washington, D.C.]. October 18, 1967.

Hungry Horse Dam and Reservoir
Columbia River Basin

Location	Storage dam and reservoir are located on the South Fork Flathead River, roughly 4 miles upstream from the confluence with the Flathead River, Flathead National Forest, Flathead County, Montana.
Function	Power production and flood control are the primary uses.
Completion Date	Construction on the dam began in 1948 and was completed in 1953, with the first water being stored in 1951. Hungry Horse Powerplant has four generating units, which were operational by 1953.

Operators Bureau of Reclamation

Minimum Streamflow Agreement

In 1954, the BR adopted a minimum streamflow release from Hungry Horse Reservoir and incorporated it into the operating criteria. Presently, the BR recognizes this original streamflow as a minimum operating flow to keep the turbines spinning at no-load. However, when this flow was recommended to the BR in 1954, it addressed the downstream fishery.

The Pacific Northwest Electric Power Planning and Conservation Act was passed by Congress in 1980. The Act formed the Northwest Power Planning Council (NPPC) and gave the Council the responsibility of developing a fish and wildlife plan for the Columbia River system and its tributaries. Montana Department of Fish, Wildlife and Parks recommended minimum streamflows for the Flathead River at Columbia Falls through the NPPC in 1982. The minimum streamflows have been included in the Columbia River Basin Fish and Wildlife Program (Northwest Power Planning Council 1984). The flows established by NPPC are for the Flathead River rather than the South Fork below Hungry Horse Dam. However, operations at Hungry Horse are to be regulated such that the flows at Columbia Falls are maintained.

Streamflow Releases

The flow amount established in 1954 was 145 cfs in the South Fork below Hungry Horse Dam. The minimum streamflows established in 1982 for the Flathead River at Columbia Falls were stable flows between a minimum of 3,500 cfs and a maximum of 4,500 cfs October 15 through April 30. In 1983, the flows were modified to provide stable flows between 3,500 cfs and 4,500 cfs from October 15 through December 15, and a minimum flow of 3,500 cfs December 16 through June 30 for incubation and emerging fry. The flows presently in effect were established in the NPPC's 1984 Fish and Wildlife Program and are a minimum of 3,500 cfs and a maximum of 4,500 cfs October 15 through December 15, and 3,500 cfs the remainder of the year.

Objective

According to a BR letter dated November 16, 1953 the minimum streamflow release of 145 cfs was to provide adequate flows for spawning cutthroat trout in the South Fork below the dam.

The minimum streamflow of 3,500 cfs in the Flathead River at Columbia Falls is to provide necessary spawning and incubation habitat for kokanee October 15 through June 30, as well as rearing habitat for bull trout, cutthroat trout, and mountain whitefish, and aquatic invertebrate production July 1 through October 15.

Information and Methods Used

The 145-cfs minimum streamflow below Hungry Horse Dam was based on observations of test flow releases. In November of 1953, the BR, FWS, and MDFWP conducted a survey to observe changes in two stream areas suitable for cutthroat spawning at flow releases ranging from 135 cfs to 1,610 cfs. Photographs and measurements of stream width and depth were taken at various flow levels.

The 1982 recommendations were based on studies conducted by MDFWP that began in 1979 and were continued through 1985. The wetted perimeter inflection point method (WETP) was applied to determine the minimum streamflow in the Flathead River that was necessary for all fish species and aquatic invertebrates. The resulting minimum streamflow determination was 3,500 cfs. Independently, 3,500 cfs was identified as the minimum streamflow necessary for kokanee from population and aquatic habitat studies. These studies included monitoring numbers of migrating and spawning kokanee, analyzing the relationship between flow conditions and kokanee year class strength, creel censuses, and monitoring survival of eggs and fry.

Recommendations

Following the 1953 joint test flow study, the FWS recommended minimum streamflows below Hungry Horse Dam of 135 to 145 cfs. The higher flow amount was accepted by the BR and incorporated into the operating procedures. It is possible that a minimum flow of 145 cfs was the operational minimum and coincided with results from the test flow study.

The FWS has not been involved in the recent flow recommendations made through the NPPC. Aquatic studies on the Flathead River have been funded by the Bonneville Power Administration pursuant to the Power Planning Act of 1980. The MDFWP made initial recommendations to the NPPC in 1982 and final results and recommendations to the council are expected by October 1989.

Streamflow Records

Station: USGS gage located immediately below Hungry Horse Dam on the South Fork of the Flathead River.
Period of record evaluated: 1954-1986

Percent of record showing streamflow discrepancies: 0.6
Percent of record showing streamflow discrepancies greater than 10 percent: 0.0

Station: USGS gage located at Columbia Falls on the Flathead River.
Period of record evaluated: 1983-1986

Percent of record showing streamflow discrepancies: 0.1
Percent of record showing streamflow discrepancies greater than 10 percent: 0.0

Since 1982, daily flows in the Flathead River at Columbia Falls have fallen below 3,500 cfs on only one occasion.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

U.S. Fish and Wildlife Service, Region 6 Office, Denver, Colorado.

Personal Communications

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Taylor, H. Bureau of Reclamation, Reservoir Regulation, Boise, Idaho. May 1987.

References

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Clancey, P., and J. Fraley. 1986. Effects of the operation of Kerr and Hungry Horse Dams on the kokanee fishery in the Flathead River System. Montana Department of Fish, Wildlife and Parks, Kalispell, Montana.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Northwest Power Planning Council. 1984. Columbia River basin fish and wildlife program. Northwest Power Planning Council, Portland, Oregon.

U.S. Bureau of Reclamation. 1983. Hungry Horse Project. U.S. Government Printing Office.

Clark Canyon Dam and Reservoir
East Bench Unit
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Beaverhead River, Beaverhead County, Montana.
Function	The project primarily stores and releases water for irrigation purposes.
Completion Date	The project was authorized by the Flood Control Acts of 1944 and 1946 (58 Stat. 887 and 60 Stat. 641). Construction began in 1960 and was completed in 1964. The first storage of water was also in 1964.
Operators	The project was sponsored and constructed by the Bureau of Reclamation. Following completion, operations were turned over to the East Bench Irrigation District, but are subject to the BR's operating criteria.
Minimum Streamflow Agreement	A formal minimum streamflow release was established in the BR's 1956 Definite Plan Report and has since been incorporated into the BR's operating criteria. There has been an informal verbal agreement between the BR and MDFWP since about 1976 to release a higher minimum streamflow amount than the one specified in the BR's operating criteria.
Streamflow Releases	The official minimum streamflow release from Clark Canyon Reservoir is 25 cfs at all times. The informal release is 200 cfs.
Objective	The original objective of the 25-cfs release was to maintain a live stream for fish and wildlife. When MDFWP negotiated the informal agreement, the objective was to maintain a high quality fishery for wild trout, and specifically maintain a trophy (brown) trout fishery. According to MDFWP biologists, an exceptional trophy trout fishery ("Blue Ribbon" fishery) has developed below Clark Canyon Dam in the Beaverhead River since the project was completed in 1964.
Information and Methods Used	The official release of 25 cfs was apparently based on operation plans. Justification for this flow amount could not be located in any of the documents or files searched. The FWS had recommended a minimum streamflow of 250 cfs below the dam in 1956 based on streamflow records. According to MDFWP biologists, there were no biological data available for the Beaverhead River below the proposed dam site at the time the project was proposed, and the department did not begin river studies until 1966. The informal release of 200 cfs was based on information collected by MDFWP between 1966 and 1980. Electrofishing surveys were conducted to estimate the fish population, and flow levels were measured and analyzed in relation to trout standing crop.
Recommendations	In 1956 the FWS recommended a minimum flow during the nonirrigation season of 250 cfs below the dam down to Barratts Diversion Dam (about 16 miles downstream) and flows of at least 200 cfs from the diversion dam to the mouth of the Ruby River. The BR responded by stating that the FWS recommendations could be partially met, but flows could go as low as 25 cfs during drought periods. The BR's 1956 operations study was based on a minimum flow of 25 cfs during the nonirrigation season, and this flow amount became the official minimum release.
Biological Evaluation	While no preproject data are available, the MDFWP began fishery studies on the Beaverhead River below Clark Canyon Dam in 1966. A relationship between long-term brown trout population estimates and daily flow data has been statistically demonstrated.
Streamflow Records	Station: BR records for flow releases from Clark Canyon Reservoir Period of record evaluated: 1964-June 1987, 25 cfs; and 1976-June 1987, 200 cfs

25-cfs release
Percent of record showing streamflow discrepancies: 0.0

200-cfs release
Percent of record showing streamflow discrepancies: 24.6
Percent of record showing streamflow discrepancies greater than 10 percent: 23.1
Percent of record showing streamflow discrepancies greater than 25 percent: 15.9
Percent of record showing streamflow discrepancies greater than 50 percent: 0.4
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Flow releases from Clark Canyon Reservoir have never been below 75 cfs and the BR attempts to keep the releases above 100 cfs. According to the verbal agreement, the BR attempts to maintain 200 cfs whenever possible. BR representatives state that low-water years and storage have resulted in flows below 200 cfs.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Montana Department of Fish, Wildlife and Parks, Bozeman, Montana.

Personal Communications

Aycock, G. Bureau of Reclamation, Reservoir Operations, Billings, Montana. June 1987.

Nelson, F. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

References

Nelson. F. 1986. Effect of flow fluctuations on brown trout in the Beaverhead River, Montana. North American Journal of Fisheries Management 6:551-559.

U.S. Bureau of Reclamation. 1956. East Bench Unit-Montana, Definite Plan Report. U.S. Department of Interior, Bureau of Reclamation, Upper Missouri Projects Office, Great Falls, Montana.

U.S. Bureau of Reclamation. 1983. Pick-Sloan Missouri Basin Program, East Bench Unit. U.S. Government Printing Office.

U.S. Fish and Wildlife Service. 1956. A detailed report on fish and wildlife resources, East Bench Unit, Montana. U.S. Department of Interior, Fish and Wildlife Service, Office of River Basin Studies, Billings, Montana.

Potosi Power Company Water Power Project
Upper Missouri River Basin

Location	The diversion structure and powerhouse are located on South Willow Creek, Beaverhead National Forest, Madison County, Montana.
Function	Power generation
Completion Date	The diversion structure and powerhouse were completed in 1986 and operations began in January of 1987.
Operators	Potosi Power Company, Inc.

Minimum Streamflow Agreement	Minimum streamflows were established in Article 29 of FERC license No. 7856 issued on October 7, 1985 to the Potosi Power Company.
Streamflow Releases	Article 29 states that the licensee shall assure a continuous discharge of 10 cfs as measured immediately below the diversion. Water can not be diverted from November 1 through April 30, or during periods when the natural flow of South Willow Creek is less than 10 cfs. Flushing flows during spring runoff are required for five consecutive days. Flows can be reduced due to operating emergencies, or for short periods with agreement from the Forest Service.
Objective	Minimum streamflows are to protect the trout fishery (rainbow, brook, and brown trout), while flushing flows during spring runoff are to maintain channel competence and to flush gravels.
Information and Methods Used	Stream surveys were conducted by MDFWP biologists in 1980 and 1983. Fish populations were surveyed by electrofishing and streamflows were measured. Streamflow data were analyzed using the wetted perimeter inflection point method (WETP).
Recommendations	In 1980, the MDFWP recommended a minimum streamflow of 14 cfs based on findings from initial stream surveys. MDFWP adjusted the recommendation down to 10 cfs based on additional findings in 1983. The FWS recommended a minimum streamflow of 10 cfs in 1984 based on the stream surveys conducted by MDFWP.
Biological Evaluation	The Cooperative Fishery Unit at Montana State University is conducting a study to evaluate the effect of altered streamflows on the fishery below the Potosi Project. Two years of preproject data have been collected, and postproject conditions are currently being evaluated.
Streamflow Records	Streamflow records are not available from USGS. Potosi Power Company installed a staff gage downstream from the diversion dam and was required by FERC to start monitoring streamflows when the project became operational. According to biologists with the Cooperative Fishery Unit, there have been no serious problems in maintaining minimum streamflows since the project went on line.

Agency Files Providing Project Information

Federal Energy Regulatory Commission, Portland, Oregon.

Montana Department of Fish, Wildlife and Parks, Bozeman, Montana.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Personal Communications

Nelson, F. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

White, B. Montana State University, Bozeman, Montana. October 1987.

References

Federal Energy Regulatory Commission. Order issuing license (minor), Potosi Power Company, Project No. 7856. Issued October 7, 1985.

Peterman, L. Montana Department of Fish, Wildlife and Parks. [Letter to Water Rights Bureau, Bozeman, Montana]. April 12, 1983.

Wood, J. U.S. Fish and Wildlife Service, Billings, Montana. [Letter to C.C. Bowman and Associates, Bozeman, Montana]. February 13, 1984.

Wood, J. U.S Fish and Wildlife Service, Billings, Montana. [Letter to C.C. Bowman and Associates, Bozeman, Montana]. March 9, 1984.

Hebgen Reservoir and Dam
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Madison River, Gallatin National Forest, Montana.
Function	Hebgen Dam stores water for power generation below Ennis Dam (Ennis Reservoir and Dam are described in the following Fact Sheet) and power generation farther downstream. Water is stored during spring runoff (mid May through early June) and released to downstream reservoirs in the fall.
Completion Date	Hebgen was constructed in 1915 by the Montana Power Company (MPC).
Operators	MPC
Minimum Streamflow Agreement	The MPC and MDFWP entered into an informal agreement concerning minimum streamflows below Hebgen and Ennis Reservoirs. The agreement as it relates to Ennis is described in the following Fact Sheet. In addition, the U.S. Forest Service and MPC entered into an agreement in 1976 concerning water releases from Hebgen Reservoir. Both agreements are still in effect and the MDFWP and MPC work closely to maintain desired minimum streamflows below Hebgen and Ennis Dams.
Streamflow Releases	The informal agreement between MDFWP and MPC provides for a minimum streamflow of 600 cfs downstream from Hebgen Dam at the Kirby Ranch USGS gage . The goal of the agreement between the Forest Service and MPC is to maximize flows in the winter and spring during low-flow periods. The agreement recommends that when releases fall below 600 cfs (reflecting the informal agreement between MDFWP and MPC), due to refilling operations during May, June, and July, that refilling be scheduled when the downstream tributaries are at high flow levels, and that at least 50 cfs be released from Hebgen in order to maintain minimum habitat below the dam downstream to the mouth of Cabin Creek (the first tributary that would increase flow levels in the Madison).
Objective	To prevent dewatering during the late winter and early spring, and maintain adequate fishery flows in the Madison River downstream from Hebgen Reservoir.
Information and Methods Used	Minimum streamflow amounts were based on historic streamflow records and professional judgement.
Recommendations	The FWS has not been involved in minimum streamflow negotiations below Hebgen Reservoir and Dam. Hebgen was licensed by FERC, and while the license specifies a minimum pool elevation, there are no minimum streamflow requirements.
Biological Evaluation	The MDFWP began to monitor trout populations in 1967. After the agreement for 600 cfs went into effect, trout response to increased streamflows was documented. Since the 1968 and 1976 agreements, MDFWP has conducted instream flow studies using the wetted perimeter inflection point method. Inflection points occurred at 600 cfs and 1,300 cfs, indicating low and high aquatic habitat potential, respectively, for the reach of stream around Kirby Bridge. This work was conducted in order for the MDFWP to file for instream

flow reservations, but the results support the flows determined in 1968, which were based on professional judgement.

Streamflow Records

Station: USGS gage located immediately below Hebgen Dam.
Period of record evaluated: 1976-1986

50 cfs
Percent of record showing minimum streamflow discrepancies: 0

Station: USGS gage at Kirby Bridge downstream from Hebgen Dam.
Period of record evaluated: 1978-1985, summer records only

600 cfs
Percent of record showing streamflow discrepancies: 3.4
Percent of record showing streamflow discrepancies greater than 10 percent: 1.0
Percent of record showing streamflow discrepancies greater than 25 percent: 0.0

According to MDFWP biologists there have been no problems maintaining the desired flow levels.

Agency Files Providing Project Information

Montana Department of Fish, Wildlife and Parks, Bozeman, Montana.

Personal Communications

Glasser, S. U.S. Forest Service, Gallatin National Forest, Bozeman, Montana. May 1987.

Nelson, F. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

Sprague, D. Montana Power Company, Butte, Montana. October 1987.

Vincent, D. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

Wells, J. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

References

Montana Department of Fish, Wildlife and Parks. 1979. Instream flow evaluation for selected streams in the Upper Missouri River Basin. Montana Department of Fish, Wildlife and Parks.

Vincent, R. 1987. Effects of stocking catchable-size hatchery rainbow trout on two wild trout species in the Madison River and O'Dell Creek, Montana. North American Journal of Fisheries Management 7:91-105.

Ennis Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Madison River near Norris, Montana, approximately 58 miles downstream from Hebgen Reservoir.
Function	Releases from Hebgen Reservoir flow into Ennis Reservoir. Ennis is used to create enough head for power generation at a facility located below the dam.
Completion Date	1908

Operators	The Montana Power Company (MPC) operates Ennis as well as Hebgen Reservoirs and Dams. Because the storage capacity of Ennis Reservoir is small, outflows from this reservoir are regulated by releases from Hebgen Reservoir.
Minimum Streamflow Agreement	An informal agreement was entered into by MDFWP and MPC in 1968 to provide minimum streamflows below Ennis Reservoir.
Streamflow Releases	The agreement calls for a minimum streamflow of 1,100 cfs below Ennis Dam.
Objective	To prevent detrimental low flows during late winter and early spring (when water is being stored upstream in Hebgen Reservoir) and to provide adequate flows for the fishery in the Madison River.
Information and Methods Used	The minimum streamflow of 1,100 cfs was based on historic streamflow records and professional judgement of MDFWP biologists.
Recommendations	The FWS has not been involved in minimum streamflow negotiations below Ennis Reservoir and Dam.
Biological Evaluation	Since the agreement was reached, MDFWP has monitored the response of the trout population to increased streamflows. In addition, MDFWP has conducted an instream flow study, using the wetted perimeter method, on this reach of the Madison. The inflection points occurred at 900 cfs and 1,350 cfs, indicating low and high aquatic habitat potential, respectively. These determinations are in close agreement with the 1,100 cfs that was determined in 1968 based on professional judgement.
Streamflow Records	Station: USGS Period of record evaluated: 1968-1986 Percent of record showing streamflow discrepancies: 2.6 Percent of record showing streamflow discrepancies greater than 10 percent: 0.9 Percent of record showing streamflow discrepancies greater than 25 percent: 0.1 Percent of record showing streamflow discrepancies greater than 50 percent: 0.0 According to MDFWP biologists and MPC representatives, there have been no serious problems maintaining desired streamflows. The MPC works in close cooperation with MDFWP regarding releases from both Hebgen and Ennis Reservoirs.

Agency Files Providing Project Information

Montana Department of Fish, Wildlife and Parks, Bozeman, Montana.

Personal Communications

Sprague, D. Montana Power Company, Butte, Montana. October 1987.

Nelson, F. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

Vincent, D. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

Wells, J. Montana Department of Fish, Wildlife and Parks, Bozeman, Montana. June 1987.

References

Montana Department of Fish, Wildlife and Parks. 1979. Instream flow evaluation for selected streams in the Upper Missouri River Basin. Montana Department of Fish, Wildlife and Parks.

Vincent, R. 1987. Effects of stocking catchable-size hatchery rainbow trout on two wild trout species in the Madison River and O'Dell Creek, Montana. North American Journal of Fisheries Management 7:91-105.

Canyon Ferry Reservoir and Dam
Canyon Ferry Unit
Upper Missouri River Basin

Location Storage dam and reservoir are located on the Missouri River, Lewis and Clark, and Broadwater Counties, Montana. Canyon Ferry is one of three reservoirs that regulate the flows of the Missouri River from Toston to Great Falls, Montana. Canyon Ferry is upstream followed by Hauser Lake and Dam and finally Holter Reservoir and Dam.

Function Canyon Ferry is a multi-purpose project, but is primarily used for power generation (three generating units) and flood control. Canyon Ferry has the largest storage capacity of the three projects and controls seasonal flows downstream, where as Hauser and Holter are run-of-river operations affecting daily flow patterns.

Completion Date Canyon Ferry was authorized by the Flood Control Act of December 22, 1944, Public Law 534. Construction began in 1949 and was completed in 1954. The first storage of water was in 1951. The Canyon Ferry Powerplant, located at the dam, began operating in 1953. The dam is located about 1.5 miles downstream from the original Canyon Ferry Dam that was built by the Montana Power Company.

Operators Bureau of Reclamation

Minimum Streamflow Agreement The Upper Missouri River Advisory Committee was formed in the fall of 1984. Members of the committee include representatives from the BR, Montana Power Company, MDFWP, Helena Valley Irrigation District, and other recreation and fishery interests. The goal of the committee is to operate the three reservoirs for the benefit of all downstream users. The committee was proposed by the MDFWP and is voluntary rather than the result of any specific State or Federal legislation (for example, the Northwest Power Planning Council was formed as a result of the Northwest Power Act of 1980, 16 U.S.C. 839). By the spring of 1985, operating guidelines for the Upper Missouri River reservoirs were established and documented by the MDFWP. The guidelines established target flows below Canyon Ferry, Hauser, and Holter Reservoirs.

Streamflow Releases Three target streamflows below Canyon Ferry have been identified by the advisory committee. The desired minimum streamflow is 4,100 cfs, whereas 3,000 cfs was identified as adequate to maintain aquatic habitat in the main river channel, but side channel habitat is lost. The critical low flow was identified as 2,400 cfs. These flows have been recommended on a year-round basis. A maximum flow of no more than 7,000 cfs was also recommended. The maximum flow addresses recreational fishing rather than channel maintenance.

Objective Hauser Dam impounds water almost up to Canyon Ferry Dam. Below Hauser there is only about 3.5 miles of flowing river before reaching the waters of Holter Lake. This short stretch of river is classified as a "Blue Ribbon" reach with rainbow and brown trout, mountain whitefish, and kokanee during fall spawning. Over 60 miles of the Missouri River below Holter Dam is also classified as a "Blue Ribbon" trout fishery. Thus, releases from Canyon Ferry Reservoir are designed to maintain the premium trout and kokanee populations below Hauser and Holter Dams.

The minimum streamflow recommendations were based on spawning, incubation, and rearing habitat requirements for brown and rainbow trout. Side channels provide important spawning and rearing habitat for both trout species. During the fall and winter a minimum and stable flow of 4,100 cfs was recommended to insure spawning and hatching conditions for brown trout and kokanee.

Information and Methods Used

River studies were conducted by the MDFWP from 1981 to 1983. The target flows of 4,100 and 3,000 cfs were based on empirical observations of side channel habitat at different flow levels. The wetted perimeter inflection point method (WETP) was used to determine the necessary flow to keep water flowing over riffle areas. This technique identified a flow of 3,000 cfs. The critical low flow of 2,400 cfs was based on observations made during low-flow periods in 1986 and 1987.

Recommendations

The FWS did not make any minimum streamflow recommendations in 1946 or 1954 when the Canyon Ferry project was being planned. Apparently there was more concern for the recreation and fishery value of the reservoir than for the downstream benefits. In a 1964 report by the FWS it was stated that "releases for peaking power are synchronized with power structures both upstream and downstream from Canyon Ferry, thus making it difficult to control the level of Canyon Ferry Reservoir during goose nesting period." It is possible that the FWS did not make minimum streamflow recommendations because flow releases were already predetermined by existing downstream demands.

The FWS has not been involved in the Upper Missouri River Advisory Committee.

Streamflow Records

Station: BR records of reservoir releases
Period of record evaluated: 1985-July 1987

2400 cfs
Percent of record showing streamflow discrepancies: 0.6
Percent of record showing streamflow discrepancies greater than 10 percent: 0.1
Percent of record showing streamflow discrepancies greater than 25 percent: 0.0

3000 cfs
Percent of record showing streamflow discrepancies: 7.5
Percent of record showing streamflow discrepancies greater than 10 percent: 3.4
Percent of record showing streamflow discrepancies greater than 25 percent: 0.1
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

4100 cfs
Percent of record showing streamflow discrepancies: 32.2
Percent of record showing streamflow discrepancies greater than 10 percent: 18.2
Percent of record showing streamflow discrepancies greater than 25 percent: 10.4
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

Low-flow periods existed in 1986 and 1987, and the BR cooperated closely with MDFWP to determine how to modify flow releases in order to provide adequate fishery flows. The established target flows are flexible and both the BR and MDFWP believe that this flexibility is advantageous in managing flows in the Missouri River.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Personal Communications

Aycock, G. Bureau of Reclamation, Reservoir Operations, Billings, Montana. June 1987.

Ervin, M. Bureau of Reclamation, Environmental Section, Billings, Montana. June 1987.

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U.S. Fish and Wildlife Service. 1954. A detailed report upon fish and wildlife resources in relation to the water development plan for the Canyon Ferry Unit. Helena-Great Falls Division, Missouri River Basin Project, Billings, Montana.

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Holter Reservoir, Lake and Dam
Upper Missouri River Basin

Location	Holter Reservoir, Lake and Dam are located on the Missouri River, Lewis and Clark County, Montana. Holter Reservoir is about 4.5 miles downstream from Hauser Dam and roughly 20 miles downstream from Canyon Ferry Dam, and is about 25 miles in length. Approximately 22 miles downstream from Holter Reservoir, or Upper Holter Lake, is a second dam (Holter Dam) creating Holter Lake.
Function	Holter Reservoir and Lake provide head for power generation. The project is a run-of-river operation.
Completion Date	Holter Dam was built in 1918. Power generating facilities were licensed by the Federal Power Commission (now FERC) in 1956.
Operators	Montana Power Company (MPC)
Minimum Streamflow Agreement	Minimum streamflows below Holter were established in 1985 by the Upper Missouri River Basin Advisory Committee and are dependent on releases from the BR's Canyon Ferry Reservoir.
Streamflow Releases	Three target flows were identified by the advisory committee for the Missouri River below Holter Dam and are identical to the recommended releases from Canyon Ferry. The desired minimum flow is 4,100 cfs; the minimum flow necessary to maintain habitat in the main channel is 3,000 cfs; the critical low flow is 2,400 cfs. A maximum flow of 7,000 cfs also was identified.
Objective	Flows below Holter are designed to provide spawning, incubation, and rearing habitat for brown and rainbow trout in the Missouri River down to the confluence with the Smith River (a "Blue Ribbon" reach). The maximum flow restriction is to prevent flooding, maintain favorable conditions for aquatic insect hatches in the late summer, and provide optimum angler conditions.
Information and Methods Used	See methods used for Canyon Ferry Reservoir and Dam.
Recommendations	The FWS has not been involved in the Missouri River Basin Advisory Committee or recent streamflow determinations below Holter Dam. In 1971, the FWS recommended that minimum streamflows below Holter Dam be included in MPC's FERC license (Nelson et al. 1976). The FWS's recommendations were not included in the FERC license.

Streamflow Records	Station: USGS Period of record evaluated: 1985-1986 2400 cfs Percent of record showing streamflow discrepancies: 0.0 3000 cfs Percent of record showing streamflow discrepancies: 0.0 4100 cfs Percent of record showing streamflow discrepancies: 18.4 Percent of record showing streamflow discrepancies greater than 10 percent: 14.5 Percent of record showing streamflow discrepancies greater than 25 percent: 11.6 Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

Personal Communications

Peterman, L. Montana Department of Fish, Wildlife and Parks, Billings, Montana. July 1987.

Spence, L. Montana Department of Fish, Wildlife and Parks, Billings, Montana. June 1987.

Sprague, D. Montana Power Company, Butte, Montana. October 1987.

References

Montana Department of Fish, Wildlife and Parks. 1985. Upper Missouri River reservoir operating guidelines for fish, wildlife and recreation, April 1985 (revised). Montana Department of Fish, Wildlife and Parks, Billings, Montana.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Tiber Dam and Lake Elwell
Lower Marias Unit
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Marias River, Toole and Liberty Counties, Montana.
Function	Authorized uses included flood control and irrigation. Once the dam and reservoir were constructed the BR could not sell the water; thus, the irrigation features have not been fully developed.
Completion Date	The project was authorized by the Flood Control Act of December 22, 1944, Public Law 534. Construction on the dam began in 1952 and was completed in 1956. The first storage of water was in 1954. Immediately following completion, the spillway began to settle, and following a flood in 1964 and heavy runoff in 1965 the settling rate increased drastically. Construction to correct the problem began in 1967 and all modifications were completed in 1981. According to BR reservoir operations, it took until about 1985-1986 to refill the reservoir.
Operators	Bureau of Reclamation

Minimum Streamflow Agreement

Provisions for a fishery flow were initially established in the BR's 1949 Definite Plan Report, and subsequently were incorporated into the BR's operating criteria for Tiber Dam and Lake Elwell.

Streamflow Releases

The official minimum streamflow release is 100 cfs. We were not able to establish precisely when this flow amount went into effect. According to BR sources, 100 cfs has been the minimum release since the project was completed. A continuous release of 30 cfs was specified in the BR's 1949 Definite Plan Report. It is possible that this was the planned minimum flow release had the irrigation features been fully developed, and that the amount was increased to 100 cfs when it was realized that the irrigation district was not going to negotiate a contract.

Since around 1977, the BR has informally agreed to release a flow of 250 cfs whenever possible. This informal agreement was the result of negotiations between the BR, MDFWP, and FWS.

Objective

To support fish and wildlife resources.

Information and Methods Used

The original recommendation of 30 cfs and the initial minimum flow release of 100 cfs were based on a field investigation conducted by the FWS and MDFWP in 1945, streamflow records, and operation plans. In the late 1960's the FWS conducted some work on the Marias River and applied the Tennant Method. The FWS used this information to recommend a minimum flow of 250 cfs when the feasibility of constructing the irrigation features was being reevaluated. Apparently, this information was used to negotiate the higher release of 250 cfs several years later.

Recommendations

In 1946, the FWS recommended a minimum streamflow of 30 cfs at any point in the Marias River between Tiber Dam and the Missouri River. This recommendation was incorporated into the BR's 1949 Definite Plan Report. Documentation reflecting the institution of the 100-cfs minimum flow could not be located. In 1969, when the irrigation features were being reevaluated, the FWS recommended a minimum flow of 250 cfs May through September, and suggested that the BR consider a flow of 250 cfs October through April and 500 cfs May through September for enhancement of the downstream fishery. Even though the proposed features were not constructed, the recommendation led to the informal release of 250 cfs several years later.

In the early 1980's, the MDFWP conducted an instream flow study on the Marias River below Tiber Dam. The wetted perimeter inflection point method (WETP) was applied to determine instream flow needs. This information is currently being used to renegotiate the minimum streamflow releases from Lake Elwell. In July of 1987, the MDFWP presented the BR with proposed minimum flow release guidelines. The proposed releases are 300 cfs as a critical low flow, 500 cfs as the minimum flow, and a desirable flow of 600 to 900 cfs. The BR is in the process of evaluating how often these flows could be met. Since Tiber Dam was constructed, water temperatures have decreased and streamflows increased; thus, the Marias River immediately below the dam has changed from a warm water to a cool water fishery. The goal of current negotiations is to maintain the aquatic conditions that have developed since project construction.

Streamflow Records

Station: BR records for releases from Lake Elwell
Period of record evaluated: 1957-1987, 100 cfs; and 1977-1987, 250 cfs

100-cfs release
Percent of records showing discrepancies: 0.3
Percent of records showing discrepancies greater than 10 percent: 0.04
Percent of records showing discrepancies greater than 25 percent: 0.04
Percent of records showing discrepancies greater than 50 percent: 0.02
Percent of records showing discrepancies greater than 75 percent: 0.02

250-cfs release
Percent of records showing discrepancies: 18.9

Percent of records showing discrepancies greater than 10 percent: 11.2
Percent of records showing discrepancies greater than 25 percent: 2.0
Percent of records showing discrepancies greater than 50 percent: 0.0

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Personal Communications

Aycock, G. Bureau of Reclamation, Reservoir Operations, Billings, Montana. June 1987.

Erwin, M. Bureau of Reclamation, Environmental Section, Billings, Montana. June 1987.

Peterman, L. Montana Department of Fish, Wildlife and Parks, Helena, Montana. July 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. August 1987.

References

Gardner, W., and R. Berg. 1983. Instream flow requirements for the Marias River downstream of Tiber Dam. Montana Department of Fish, Wildlife and Parks, Great Falls, Montana.

U.S. Bureau of Reclamation. 1949. Lower Marias Unit-Definite Plan Report. U.S. Department of Interior, Bureau of Reclamation, Billings, Montana.

U.S. Bureau of Reclamation. 1983. Pick-Sloan Missouri Basin Program, Lower Marias Unit. U.S. Government Printing Office.

U.S. Fish and Wildlife Service. 1969. A report on the fish and wildlife resources affected by the Marias-Milk Unit, Montana. U.S. Department of Interior, Fish and Wildlife Service, Twin Cities, Minnesota.

Mystic Lake Project
Upper Missouri River Basin

Location	Storage dam and reservoir are located on West Rosebud Creek, a tributary of the Stillwater River, in Custer National Forest, Stillwater County, Montana.
Function	Power generation
Completion Date	Construction began in 1920 and was completed in 1927. The first generation of power was in 1925. A reregulating dam was constructed below the powerhouse in 1979. The project was licensed by the Federal Power Commission (now FERC) in 1962.
Operators	Montana Power Company
Minimum Streamflow Agreement	The initial FERC license expired in 1969, and the project operated under annual licenses until a new license was issued October 5, 1976. Minimum streamflows were established in Article 34 of the 1976 license. An amendment to the license was issued in 1981 that made minor changes to the required minimum streamflows.
Streamflow Releases	The 1976 FERC license required, until a permanent release schedule could be established, a minimum flow of 10 cfs during June, July, and August, and 2 cfs the remainder of the year at the weir located upstream from the powerhouse. In addition, a minimum release of 20 cfs was required below the reregulating dam, except when inflow was less than

20 cfs, in which case the outflow would equal the inflow. After further stream studies by Montana Power Company, an amendment was approved and issued in 1981 that changed the minimum streamflow releases from 2 cfs to 3 cfs September through May or the inflow to the reservoir, whichever is less. The minimum flow June through August is still 10 cfs or the inflow to the reservoir, whichever is less.

Objective

To protect and enhance the aquatic resources in West Rosebud Creek.

Information and Methods Used

The FWS, with cooperation from the FS, determined minimum streamflow requirements for West Rosebud Creek based on the Tennant Method.

Recommendations

In 1972, during the relicensing period, the FWS recommended a minimum streamflow release from Mystic Lake of 10 cfs year-round. The FWS reiterated this recommendation in 1974. However, the Montana Power Company objected to a year-round release of 10 cfs because it would cause a 12 percent reduction in energy production. Thus, the flow regime specified in the 1976 FERC license was agreed to until the problem could be further evaluated. Several years later, after reevaluating information collected by the FWS, streamflow records, and project operations, the Montana Power Company recommended a minimum flow of 3 cfs September through May and 10 cfs June through August. According to the FERC 1981 amendment, the FWS accepted this flow regime in a letter dated February 19, 1981. The MDFWP did not offer any minimum streamflow recommendations.

The FS recommended the 20-cfs release below the reregulating dam. The Montana Power Company accepted this recommendation in 1972, prior to construction of the reregulating dam.

Streamflow Records

None

FERC inspects the Mystic Lake Project annually. Based on the FERC inspection reports for 1985 and 1986, the Montana Power Company has been releasing the minimum streamflows stipulated in Article 34 of the FERC license. Currently, the MDFWP is more concerned with maintaining the reservoir elevation and fish habitat in Mystic Lake than with the downstream fishery.

Agency Files Providing Project Information

Federal Energy Regulatory Commission, Portland, Oregon.

Federal Energy Regulatory Commission, Washington, D.C.

Montana Department of Fish, Wildlife and Parks, Billings, Montana.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

U.S. Fish and Wildlife Service, Regional Office, Denver, Colorado.

Personal Communications

Fredenberg, W. Montana Department of Fish, Wildlife and Parks, Billings, Montana. June 1987.

Sprague, D. Montana Power Company, Butte, Montana. October 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. August 1987.

References

Federal Energy Regulatory Commission. Order issuing major license, Montana Power Company, Project No. 2301. Issued October 5, 1976.

Federal Energy Regulatory Commission. Order amending license and setting minimum flows, Montana Power Company, Project No. 2301. Issued August 21, 1981.

U.S. Department of Interior, Office of the Secretary. [Letter to Federal Power Commission, Washington, D.C.]. June 16, 1975.

U.S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. [Memorandum to Director, Office of Environmental Review]. 1974.

Bighorn Lake Reservoir and Yellowtail Dam
Yellowtail Unit
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Bighorn River. Bighorn Lake lies almost north-south across the Wyoming-Montana border near Lovell, Wyoming. Yellowtail Dam and Powerplant are located in Big Horn County, Montana.
Function	The Yellowtail Unit was constructed as a multi-purpose project; uses include power production, irrigation, and flood control.
Completion Date	Yellowtail Unit was authorized by the Flood Control Act of December 22, 1944, Public Law 534. Construction on the dam began in 1961 and was completed in 1966. Water was first stored in 1965 and the four generating units began operation in 1966. Yellowtail Afterbay Dam was completed in 1965.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	A formal minimum streamflow release was established in the BR's 1950 Definite Plan Report. The minimum streamflow release was subsequently incorporated into the operating criteria for the Yellowtail Unit. In 1986, the MDFWP presented the BR with target fishery flow guidelines. The BR conducted simulations to determine how often the flows could be maintained. Consequently, the BR and MDFWP entered into an informal agreement to maintain the target flows as often as possible.
Streamflow Releases	The official minimum flow release below Yellowtail Dam is 1,000 cfs year-round. The target flows that were informally agreed upon are an optimum year-round release of 2,500 cfs, a standard release during average flow periods (but not drought periods) of 2,000 cfs, and a minimum flow of 1,500 cfs to be released during drought periods.
Objective	The official release of 1,000 cfs was expected to maintain aquatic habitat and the downstream fishery. In FWS preliminary investigations in 1950, it was stated that substantial improvements in fish habitat could be expected if the BR maintained a minimum flow of 800 cfs May 1 through October and 500 cfs during the remaining winter months. Prior to construction, the Bighorn River was warm and silty, but a cold, clear water trout fishery has developed since the project was completed in 1966. The target flows developed by MDFWP address the cold water fishery that has developed since the project was constructed. The flows specifically address spawning, rearing, and cover requirements for brown and rainbow trout. Since many of the habitat requirements are found in the side channels, an optimum flow of 2,500 cfs provides side channel habitat, whereas most of this habitat is lost when flows fall below 2,000 cfs.
Information and Methods Used	The official release of 1,000 cfs was apparently based on water supply studies, operational requirements, and downstream demands.

The unofficial target flows were determined by MDFWP. The department began studies on the Bighorn River below Yellowtail in 1970. In 1976, the water surface profile method was applied to determine instream flow needs. Since 1981, brown and rainbow trout populations have been monitored by electrofishing surveys and tagging studies. The relationship between the amount of side channel habitat and flows ranging from 1,600 cfs to 2,900 cfs was measured and photographed during 1985.

Recommendations

The FWS submitted recommendations to the BR in 1948 and these were included in the BR's Definite Plan Report. The FWS recommended a minimum mean monthly flow of 800 cfs during May through October, a minimum mean monthly flow of 500 cfs November through April, and an instantaneous minimum flow of 400 cfs at all times. The BR had already planned to release a minimum flow of 1,000 cfs in order to satisfy operational and downstream irrigation requirements. Thus, the FWS recommendations were satisfied. In a 1960 report, the FWS stated that a minimum instantaneous flow of not less than 1,000 cfs was needed for the downstream fishery. The MDFWP concurred with the 1960 recommendations in a letter dated December 15, 1961.

The FWS was not involved in the informal agreement reached between MDFWP and the BR in 1985. The MDFWP began investigations on the Bighorn River in response to State instream flow legislation that was passed in 1969. The study results were used to support a filing for an instream flow reservation near the mouth of the Bighorn River, as well as to initiate negotiations with the BR for higher releases from Bighorn Lake.

Biological Evaluation

Since 1981, the MDFWP has monitored brown and rainbow trout populations. Brown trout populations have closely mirrored streamflow conditions, whereas rainbow trout population levels have reflected stocking levels.

Streamflow Records

Station: BR records of releases from Bighorn Lake
Period of record evaluated: 1967-1987

1000 cfs 1967-1987
Percent of record showing streamflow discrepancies: 1.1
Percent of record showing streamflow discrepancies greater than 10 percent: 0.9
Percent of record showing streamflow discrepancies greater than 25 percent: 0.7
Percent of record showing streamflow discrepancies greater than 50 percent: 0.5
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

1500 cfs 1985-1987
Percent of record showing streamflow discrepancies: 0.4
Percent of record showing streamflow discrepancies greater than 10 percent: 0.2
Percent of record showing streamflow discrepancies greater than 25 percent: 0.2
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

2000 cfs 1985-1987
Percent of record showing streamflow discrepancies: 2.9
Percent of record showing streamflow discrepancies greater than 10 percent: 0.9
Percent of record showing streamflow discrepancies greater than 25 percent: 0.4
Percent of record showing streamflow discrepancies greater than 50 percent: 0.2
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

2500 cfs
Percent of record showing streamflow discrepancies: 17.8
Percent of record showing streamflow discrepancies greater than 10 percent: 10.2
Percent of record showing streamflow discrepancies greater than 25 percent: 1.5
Percent of record showing streamflow discrepancies greater than 50 percent: 0.2
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Montana Department of Fish, Wildlife and Parks, Billings, Montana.

Personal Communications

Aycock, G. Bureau of Reclamation, Reservoir Operations, Billings, Montana. June 1987.

Fredenberg, W. Montana Department of Fish, Wildlife and Parks, Billings, Montana. June 1987.

References

Flynn, J. Montana Department of Fish, Wildlife and Parks. [Letter to D. Christenson, Yellowtail Project Superintendent, Hardin, Montana]. 1986 August 6.

Martin, B. Regional Director, Bureau of Reclamation. [Letter to S. McMullen, Montana Department of Fish, Wildlife and Parks, Billings, Montana]. 1986 October 22.

Montana Department of Fish, Wildlife and Parks. 1986. Bighorn Lake and Bighorn River post-impoundment study. Montana Department of Fish, Wildlife and Parks, Fisheries Division, Job Progress Report, Project No. F-20-R-30.

Montana Department of Fish, Wildlife and Parks. 1986. Upper Bighorn River fisheries management plan (draft). Montana Department of Fish, Wildlife and Parks.

U.S. Bureau of Reclamation. 1950. Yellowtail Unit-Montana, Lower Big Horn Division, Definite Plan Report, 1950. U.S. Department of Interior, Bureau of Reclamation, Billings, Montana.

U.S. Bureau of Reclamation. 1983. Pick-Sloan Missouri Basin Program, Yellowtail Unit. U.S. Government Printing Office.

U.S. Fish and Wildlife Service. 1962. Fish and wildlife resources and the Yellowtail Unit. Bureau of Sport Fisheries and Wildlife, Missouri River Basin Studies, Billings, Montana.

FACT SHEETS FOR WYOMING

Buffalo Bill Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Shoshone River, Park County, near Cody, Wyoming.
Function	Power generation and irrigation
Operators	Bureau of Reclamation
Completion Date	Buffalo Bill Dam was completed in 1910 and modified in 1915, 1922-1923, 1959, and is currently being reconstructed. Heart Mountain Powerplant has been operating since 1948. Shoshone Powerplant, 300 feet below the dam, began operating in 1922 but has since been deactivated.
Minimum Streamflow Agreement	In May of 1982, the WGFD, FWS, and BR entered into an "Operation Agreement for Buffalo Bill Dam and Reservoir." The agreement established year-round minimum streamflows below the dam and below Heart Mountain Powerplant. Prior to 1982, the BR had non-irrigation season operating criteria, implemented in 1969, which provided minimum flows below Shoshone and Heart Mountain Powerplants.
Streamflow Releases	The 1982 agreement established the following releases: 1. A minimum flow of 100 cfs from Shoshone Powerplant to Heart Mountain Powerplant. 2. A minimum flow of 350 cfs below Heart Mountain Powerplant, to be measured at the USGS gage located approximately 4 miles downstream from the powerplant. 3. A minimum flushing flow of 2,300 cfs through the entire Shoshone River for a minimum of 4 days during spring runoff. Various conditions in the agreement allow the BR to reduce the stated minimum flows, including low inflow to the reservoir and amount of storage required to meet user needs who pay for allocated storage space in Buffalo Bill Reservoir. A memorandum dated May 18, 1979 from the BR to the FWS stated that BR operating criteria, beginning in 1969, required a minimum flow of 15 to 50 cfs below Shoshone Powerplant (depending on ice cover), and a 200-cfs minimum flow below Heart Mountain Powerplant during the nonirrigation season (November through April). Releases were dependent on inflow to the reservoir and storage conditions.
Objective	To assure maintenance of the downstream aquatic ecosystem. In addition, the flows between Shoshone and Heart Mountain Powerplants are intended to dilute high sulphur concentrations resulting from sulphur springs located below the dam. According to the 1979 Draft Environmental Statement for the modification of Buffalo Bill Dam, the minimum streamflows, later established in the 1982 agreement, were expected to improve the downstream fishery.
Information and Methods Used	The minimum streamflows stated in the BR's operating criteria beginning in 1969 were the result of negotiations and the Tennant Method applied to the Shoshone River below Buffalo Bill by the FWS in the late 1960's.

Minimum streamflows established in the 1982 agreement were determined from field studies conducted by FWS, WGFD, and BR. Stream cross section studies were conducted, and a modified water-surface profile and IFG4 methodologies were applied to determine minimum streamflow amounts.

Recommendations In 1977, the FWS and WGFD recommended a minimum flow of 100 cfs below the dam, 350 cfs below Heart Mountain, and a flushing flow of 2,300 cfs in response to the BR's proposed plans to modify the Buffalo Bill Dam. These modifications have not been completed but the minimum flow agreement went into effect with its signing in 1982.

Streamflow Records Station: USGS below Heart Mountain Powerplant
Period of record evaluated: 1969-1985 (200 cfs 1969-1981 and 350 cfs 1982-1985)

Percent of record showing streamflow discrepancies: 2.7
Percent of record showing streamflow discrepancies greater than 10 percent: 1.9
Percent of record showing streamflow discrepancies greater than 25 percent: 0.0

There is no streamflow gage immediately below the dam; thus, we did not evaluate minimum flows between the dam and Heart Mountain Powerplant. The BR calculates releases from the dam based on the amount of water flowing through the Heart Mountain Powerplant. In addition, streamflow records are not available to allow us to evaluate the amount of inflow to the reservoir.

Streamflows below Heart Mountain Powerplant were below the minimum during 1977, 1978, and 1982. Flows have been reduced mostly as a result of the reconstruction work on the dam.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Enhancement Office, Billings, Montana.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Aycock, G. U.S. Bureau of Reclamation, Reservoir Operations, Billings, Montana. June 1987.

Lloyd, J. Formerly with the U.S. Fish and Wildlife Service, Billings, Montana. July 1987.

McKnight, R. Wyoming Game and Fish Department, Cody, Wyoming. October 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. September 1987.

Wood, G. U.S. Fish and Wildlife Service, Billings, Montana. June 1987.

References

Regional Director, Bureau of Reclamation. [Memorandum to Area Manager, Fish and Wildlife Service, Billings, Montana]. 1979 May 18.

Regional Director, U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Bureau of Reclamation, Region 6, Billings, Montana]. 1968 July 18.

U.S. Bureau of Reclamation. 1968. Report on plans for modification of Buffalo Bill Dam, Wyoming, Shoshone Project. U.S. Department of Interior, Bureau of Reclamation, Billings, Montana.

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U.S. Bureau of Reclamation. 1980. Shoshone Project, Montana: Carbon County, Wyoming: Big Horn and Park Counties. U.S. Government Printing Office, Denver, Colorado.

Shoshone Lake Dam and Reservoir

Upper Missouri River Basin

Location	Storage dam and reservoir are located on Shoshone Creek, tributary of the Popo Agie River, Shoshone National Forest, Fremont County, Wyoming.
Function	Irrigation
Operators	Shoshone Lake Reservoir Company
Completion Date	The original reservoir was constructed in 1938 and apparently was abandoned and the dam washed out. In the late 1950's the dam was rebuilt and the reservoir was enlarged.
Minimum Streamflow Agreement	A FS special use permit for the reconstruction, issued in 1955, established minimum and maximum streamflow releases from Shoshone Lake Reservoir.
Streamflow Releases	The minimum streamflow requirement immediately below the dam is 2 cfs. In 1960, the allowed maximum flow below the dam was 110 cfs. Thereafter, the allowed maximum flow was 130 cfs as long as no bank erosion problems occurred.
Objective	To preserve and prevent damage to fish habitat. The maximum flow restriction addresses channel maintenance.
Information and Methods Used	Professional judgment and field observations made by FWS biologists in 1951. The FWS and WGFD conducted some work below Shoshone Lake Reservoir in the late 1960's using the Tennant or Montana Method, but the project was completed and the stream work reflected field testing of the new methodology.
Recommendations	In 1957 the FWS recommended that the FS permit include a minimum flow below the dam of no less than 2 cfs, and that the maximum flow be no greater than 65 cfs, provided that if a flow greater than 65 cfs was necessary, adequate provisions be made to prevent downstream erosion. Even though the FS permit is dated 1955, it was not officially signed by the Forest Supervisor and Reservoir Company until 1959 and 1960, respectively.
Streamflow Records	None The WGFD and FS are not aware of any serious problems associated with maintaining minimum streamflows below Shoshone Lake Reservoir. However, the agencies do not routinely monitor the project.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Wyoming State Engineers Office, Cheyenne, Wyoming.

Personal Communications

Connel, K. Wyoming Game and Fish Department, Lander, Wyoming. July 1987.

Rossman, B. U.S. Forest Service, Shoshone National Forest, Lander, Wyoming. October 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. September 1987.

References

Regional Director, Fish and Wildlife Service. [Letter to Forest Supervisor, Shoshone National Forest, Cody, Wyoming]. 1957 January 28.

U.S. Forest Service. 1955. Special Use Permit, Shoshone Lake Reservoir Company. Shoshone National Forest, Lander, Wyoming.

Frye Lake Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on Townsend Creek, Shoshone National Forest, Fremont County, Wyoming.
Function	Irrigation
Operators	Enterprise Irrigation and Power Company
Completion Date	The original reservoir was constructed in 1940 and enlarged later that same year. The reservoir was enlarged again in 1972.
Minimum Streamflow Agreement	A FS special use permit, issued in 1973 for operation of the reservoir, established minimum flows below the dam. Apparently, a FS permit had been issued in 1908 for the original construction and another in 1970 for the second enlargement, but neither contained minimum streamflow requirements.
Streamflow Releases	The required minimum instantaneous flow from the reservoir outlet is 2 cfs at all times except when the inflow to the reservoir is less than 2 cfs, in which case the downstream release will equal the amount of inflow. The maximum flow release is 90 cfs.
Objective	To provide and maintain optimum fish habitat. The maximum flow restriction addresses channel maintenance.
Information and Methods Used	According to the WGFD, the minimum streamflow amount was based on professional judgment and field observations.
Recommendations	A record of the FWS and WGFD recommendations could not be located. Information from the WGFD indicates that their recommendation to the FS was for a minimum flow of 2 cfs below the reservoir.
Streamflow Records	None
	The WGFD and FS are not aware of any problems associated with maintaining the minimum streamflow below Frye Lake Reservoir. However, the agencies do not routinely monitor the project.

Agency Files Providing Project Information

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Connel, K. Wyoming Game and Fish Department, Lander, Wyoming. July 1987.

Rossman, B. U.S. Forest Service, Shoshone National Forest, Lander, Wyoming. October 1987.

References

U.S. Forest Service. 1973. Special Use Permit, Enterprise Irrigation and Power Company. Shoshone National Forest, Lander, Wyoming.

Boysen Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the Wind River approximately 20 miles south of Thermopolis in Fremont County, Wyoming.
Function	Primarily power production and irrigation
Operators	Bureau of Reclamation
Completion Date	Boysen Dam was completed in 1952 and first storage of water began in 1951. Boysen Powerplant began operation in 1952.
Minimum Streamflow Agreement	Since 1968 the BR has incorporated a minimum streamflow release for fish in the operating criteria for Boysen Dam and Reservoir. The minimum streamflow release resulted from a 1968 request by the BR for WGFD to identify desirable or essential flows to maintain a suitable fishery below Boysen Dam before the BR considered the sale of additional water for industry and additional irrigation development. Prior to 1968, there was an operational minimum release of 100 cfs.
Streamflow Releases	The minimum streamflow below Boysen Dam is 250 cfs. This is considered a minimum amount to be released during droughts and low-water years. The desired minimum streamflow for fish is 400 cfs, and the BR releases this amount whenever possible. The absolute minimum flow that is required to operate the generators is 100 cfs.
Objective	In 1968, the WGFD and FWS recommended that a minimum instantaneous flow of 250 to 400 cfs during the nonirrigation season would preserve the existing fishery. According to BR operators, flows during the irrigation season are usually around 1,200 cfs.
Information and Methods Used	During October of 1968 the BR, FWS, and WGFD conducted a streamflow study. Flow regimes of 250, 400, and 700 cfs were observed and photographed in a 50-mile reach of the Wind River below Boysen Dam. In addition, the 400 cfs was based on one-third of the average annual discharge during the period of 1951-1960 (Tennant method).
Recommendations	When the Boysen Dam and Reservoir project was originally proposed, in the early 1940's, the FWS recommended a minimum flow of 700 cfs to be maintained from Boysen Dam to Kirby, Wyoming. In the BR's 1954 General Plan for the Boysen Unit, it was stated that the FWS recommendations would be followed to the extent that physical conditions and operating demands permit, but the recommendations were not incorporated into the operating criteria. Only the minimum operational flow of 100 cfs during the nonirrigation season

was included. In 1968 the BR, FWS, and WGFD conducted the above streamflow studies, in response to the BR's request, and recommended a minimum instantaneous flow of 250 to 400 cfs during the nonirrigation season, with the understanding that a release of 250 cfs would only be made during periods of drought or low water years.

Streamflow Records

Station: USGS
Period of record evaluated: 1952-1985 (1952-1967, 100 cfs minimum; 1968-1985, 250 cfs minimum)

Percent of record showing streamflow discrepancies: 0.1
Percent of record showing streamflow discrepancies greater than 10 percent: 0.1
Percent of record showing streamflow discrepancies greater than 25 percent: 0.1
Percent of record showing streamflow discrepancies greater than 50 percent: 0.1
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Streamflows of 400 cfs have been maintained about 98 percent of the time since 1968.

According to the WGFD, there have been no problems with the maintenance of minimum streamflows below Boysen Dam and Reservoir.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Aycock, G. U.S. Bureau of Reclamation, Reservoir Operations, Billings, Montana. June 1987.

Connel, K. Wyoming Game and Fish Department, Lander, Wyoming. July 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. September 1987.

References

Tennant, D. 1968. Boysen Unit, Wyoming (BR) - Observation of test flows October 1-3, 1968. U.S. Fish and Wildlife Service, Billings, Montana. Unpublished report.

U.S. Bureau of Reclamation. 1954. Report on Boysen Unit-Wyoming, Boysen Division, Missouri River Basin Project, Volume I - General Plan. U.S. Department of Interior, Bureau of Reclamation, Bighorn Basin Projects Office, Cody, Wyoming.

U.S. Bureau of Reclamation, Regional Director. [Letter to Director, Wyoming Game and Fish Commission, Cheyenne, Wyoming]. 1968 July 12.

U.S. Bureau of Reclamation. 1980. Pick-Sloan Missouri Basin Program, Boysen Unit, Wyoming: Fremont County. U.S. Government Printing Office, Denver, Colorado.

U.S. Fish and Wildlife Service. 1969. Fish and wildlife and the Boysen Unit, Wyoming, initial follow-up report. U.S. Department of Interior, Fish and Wildlife Service, Minneapolis, Minnesota.

Shell Creek Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on Shell Creek, Bighorn National Forest, Bighorn County, Wyoming.
Function	Irrigation
Operators	Shell Creek Reservoir Corporation
Completion Date	1957
Minimum Streamflow Agreement	A FS special use permit was issued in August 1955 which established minimum streamflow releases and maximum flow restrictions below Shell Creek Reservoir.
Streamflow Releases	The minimum streamflow requirement immediately below the dam is 6 cfs during November, December, January, February, and March, unless the inflow to the reservoir is less than 6 cfs, in which case the streamflow below the dam will be equal to the inflow. The minimum flow release during April, August, September, and October is 10 cfs, and 20 cfs during May, June, and July. Releases from Shell Creek Reservoir shall be no greater than 100 cfs.
Objective	To promote the maintenance of good fish habitat conditions. The maximum flow restriction addresses channel maintenance.
Information and Methods Used	We were unable to locate this information in FWS or WGFD records. According to FWS biologists, the Tennant method was applied to Shell Creek in the late 1960's or early 1970's, but apparently was not related to the minimum streamflow releases as they had already been established.
Recommendations	We were unable to locate the original recommendations made by the FWS and WGFD in either FWS or WGFD files.
Streamflow Records	There is a USGS gage upstream of Shell Creek Reservoir but there are no records immediately below the reservoir. Minimum streamflow releases, according to the FS special use permit, were to be measured 300 feet below the outlet.

Agency Files Providing Project Information

U.S. Forest Service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Wyoming State Engineers Office, Cheyenne, Wyoming.

Personal Communications

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. October 1987.

References

U.S. Forest Service. 1954. Special Use Permit, Shell Creek Reservoir Company. Bighorn National Forest, Sheridan, Wyoming.

Dull Knife Dam and Reservoir
North Fork Powder River Watershed Project
Upper Missouri River Basin

Location	Storage dam and reservoir are located on the North Fork of the Powder River, Johnson County, Wyoming.
Function	Irrigation
Operators	North Fork Water Users Association
Completion Date	1966
Minimum Streamflow Agreement	A minimum streamflow release during the nonirrigation season was incorporated into the 1963 Soil Conservation Service Watershed Work Plan.
Streamflow Releases	The minimum streamflow release is 2.5 cfs September through March, provided that the release rate does not reduce winter storage of the reservoir. The minimum streamflow release is not considered an official release, as it is not a stipulation of a permit or license, but the SCS did accept the minimum flow releases in a letter dated June 24, 1963 to the FWS, and incorporated the minimum flow release into their work plan.
Objective	To preserve the stream below Dull Knife Reservoir as a fishery.
Information and Methods Used	Cursory field observations and professional judgment were used to determine the minimum flow release.
Recommendations	Originally the WGFD recommended a minimum release of 5 cfs or the inflow, whichever is less. However, in 1963 the FWS recommended a minimum release of 2.5 cfs September through March and the WGFD concurred. In a letter dated January 22, 1963 to the FWS, WGFD stated that the release of 2.5 cfs appeared to be satisfactory and possibly superior to their original recommendation of 5 cfs because it would stabilize winter flows.
Streamflow Records	Downstream Station: USGS Period of record evaluated: 1975-1985 Percent of record showing streamflow discrepancies: 43.8 Percent of record showing streamflow discrepancies greater than 10 percent: 41.5 Percent of record showing streamflow discrepancies greater than 25 percent: 34.4 Percent of record showing streamflow discrepancies greater than 50 percent: 15.7 Percent of record showing streamflow discrepancies greater than 75 percent: 0.0 Upstream Station: USGS Period of record evaluated: 1975-1985 Percent of record showing streamflow discrepancies when upstream flows were at least 2.5 cfs on the same day: 20.1 Percent of record showing streamflow discrepancies greater than 10 percent: 18.3 Percent of record showing streamflow discrepancies greater than 25 percent: 16.5 Percent of record showing streamflow discrepancies greater than 50 percent: 3.9 Percent of record showing streamflow discrepancies greater than 75 percent: 0.0 According to the dam operators, after the last call for irrigation is received the gates are set to release the amount of inflow at that time (determined by the upstream gage).

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Gilbert, T. Soil Conservation Service, Casper, Wyoming. October 1987.

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

Roydan. Dull Knife Reservoir Operator, Kaycee, Wyoming. October 1987.

References

Chief, Division of Technical Services, Bureau of Sport Fisheries and Wildlife. [Memorandum to Engineering Assistant, Office of Assistant Secretary, Water and Power Development]. 1963 August 2.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Regional Director, U.S. Fish and Wildlife Service. [Letter to State Conservationist, Soil Conservation Service, Casper, Wyoming]. 1963 June 4.

Rockett, L. Wyoming Game and Fish Commission. [Letter to Area Supervisor, Missouri River Basin Studies, Billings, Montana]. 1963 January 22.

Rockett, L. 1981. Instream flow data for ten Area 30 streams. Wyoming Game and Fish Department, Fish Division, Administrative Report.

Cloud Peak Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on South Piney Creek, Bighorn National Forest, Johnson County, Wyoming.
Function	Irrigation
Operators	Rock Creek and Piney Creek Reservoir and Ditch Company
Completion Date	Cloud Peak Reservoir and Dam were originally constructed around 1900. The storage capacity was enlarged in 1958.
Minimum Streamflow Agreement	In 1956, a FS special use permit was issued for the reconstruction and enlargement of Cloud Peak Reservoir. The permit established minimum streamflow releases and maximum flow restrictions.
Streamflow Releases	The minimum streamflow requirement immediately below the dam is 5 cfs, provided that whenever the inflow is less than 5 cfs, streamflow releases can equal the inflow. Releases shall be no greater than 75 cfs.

Objective	To prevent damage to fish habitat. The maximum flow restriction addresses channel maintenance.
Information and Methods Used	A two-day field investigation was conducted by the FWS and WGFD in August of 1955. Streamflows were approximated, and aquatic habitat and wildlife were evaluated.
Recommendations	According to Nelson et al. (1976), in 1956 the FWS recommended a 2- to 3-cfs minimum release, which was the amount of leakage from the existing dam. In a letter dated April 17, 1956 to the FS, the WGFD recommended a minimum flow of 5 cfs below Cloud Peak Reservoir.
Streamflow Records	None
	The WGFD is not aware of any problems associated with maintaining the minimum streamflows below the reservoir. However, the flows are not monitored by the FS or WGFD.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, Enhancement Office, Billings, Montana.

U.S. Forest Service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

Nessor, J. U.S. Forest Service, Bighorn National Forest, Sheridan. April 1987.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Willow Park Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on South Piney Creek five miles downstream from Cloud Peak Reservoir, Bighorn National Forest, Johnson County, Wyoming.
Function	Irrigation
Operators	Willow Park Reservoir Company
Completion Date	Willow Park was constructed at the same time that Cloud Peak was enlarged. The project was completed in 1958.
Minimum Streamflow Agreement	A FS special use permit issued in 1956 established minimum and maximum streamflow releases below Willow Park Reservoir.

Streamflow Releases

The minimum flow requirement immediately below the dam is 10 cfs during November, December, January, February, and March, provided that whenever the inflow is less than 10 cfs the streamflow below the dam can equal the inflow. The minimum flow release is 15 cfs during April, August, September, and October, and 50 cfs during May, June, and July.

Maximum flows below the dam shall be no greater than 175 cfs except during periods when the inflow to the reservoir exceeds 175 cfs.

Objective

To prevent damage to fish habitat below the reservoir. The maximum flow restriction addresses channel maintenance.

Information and Methods Used

A two-day field investigation was conducted by the FWS and WGFD in August of 1955. Streamflows were approximated and aquatic habitat and wildlife evaluated.

Recommendations

In a letter to the FS dated May 4, 1956, the FWS recommended minimum streamflow releases below Willow Park Reservoir identical to those stipulated by the 1956 FS special use permit. The WGFD concurred with the FWS's recommendations.

Streamflow Records

Gage: USGS
Period of record evaluated: 1960-1985

Percent of record showing minimum streamflow discrepancies: 41.2
Percent of record showing streamflow discrepancies greater than 10 percent: 39.1
Percent of record showing streamflow discrepancies greater than 25 percent: 35.5
Percent of record showing streamflow discrepancies greater than 50 percent: 22.7
Percent of record showing streamflow discrepancies greater than 75 percent: 12.1

WGFD biologists were not aware of any serious problems, other than low natural flows above the reservoir, associated with maintenance of minimum streamflows below Willow Park.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, Enhancement Office, Billings, Montana.

U.S. Forest Service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

Nessor, J. U.S. Forest Service, Bighorn National Forest, Sheridan. April 1987.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Kearney Lake Dam and Reservoir

Upper Missouri River Basin

Location	Storage dam and reservoir are located on Kearney Creek, Bighorn National Forest, Johnson County, Wyoming.
Function	Irrigation
Operators	Kearney Lake Reservoir Company
Completion Date	Kearney Lake was enlarged by the Kearney Lake Reservoir Company in 1961.
Minimum Streamflow Agreement	In 1961, a FS special use permit was issued for the enlargement of Kearney Lake Reservoir. The permit established minimum streamflow releases below the reconstructed dam.
Streamflow Releases	The minimum flow requirement immediately below the dam is 5 cfs, provided that whenever the inflow is less than 5 cfs, the streamflow immediately below the dam shall be equal to the amount of inflow.
Objective	To prevent damage to fish habitat below the reservoir.
Information and Methods Used	According to WGFD biologists, the minimum streamflow was most likely determined using professional judgment and field observations. There were no records of the information used to determine the minimum streamflow amount in FWS or WGFD files.
Recommendations	A record of recommendations offered by the FWS and WGFD could not be located in FWS or WGFD files.
Streamflow Records	There are no current streamflow records below Kearney Lake Reservoir. Incomplete records from a USGS gage are available for 1971, 1976, and 1977, but we were not able to evaluate maintenance of minimum streamflows using this information. The WGFD is not aware of any problems associated with the maintenance of minimum streamflows below Kearney Lake. However, the project is not routinely monitored by WGFD or FS personnel.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Forest Service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

References

U.S. Forest Service. 1961. Special Use Permit, Kearney Lake Reservoir Company. Bighorn National Forest, Sheridan, Wyoming.

Cross Creek Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on Cross Creek, Bighorn National Forest, Johnson County, Wyoming.
Function	Irrigation
Operators	Cross Creek Irrigation Reservoir, Garber Brothers, Inc.
Completion Date	Originally constructed in 1958 and enlarged in 1975.
Minimum Streamflow Agreement	A FS special use permit was issued in 1953 for construction of the reservoir and dam, and was modified in September 1955 to include minimum streamflow releases. In 1975 a FS special use permit was issued for the enlargement of Cross Creek Reservoir. The 1975 permit supersedes the earlier permit, but the minimum streamflow requirements were retained.
Streamflow Releases	A minimum instantaneous release of 2 cfs is required from the reservoir outlet at all times except when the inflow is less than 2 cfs, in which case the downstream flow will be equal to the inflow. There is a maximum release of no more than 75 cfs at any time.
Objective	To provide and maintain optimum fish habitat. The maximum flow restriction addresses channel maintenance.
Information and Methods Used	Originally, a joint field investigation was conducted by the FWS, WGFD, and FS, using one year of streamflow records and the project plans. In 1970, when the operators applied for a FS permit to enlarge the reservoir, the FWS and WGFD conducted another field investigation and applied the Tennant method.
Recommendations	In July of 1955 the FWS recommended a minimum flow of 2 cfs November through August or the inflow, whichever is less. Additionally, it was recommended that during September and October the minimum flow release be equal to the inflow unless the inflow was greater than 6 cfs, in which case the excess could be stored. A maximum flow of 75 cfs was also recommended. In a 1971 evaluation report on the enlargement of Cross Creek Reservoir, the FWS reiterated its 1955 recommendations. The WGFD concurred in a letter dated January 20, 1971.
Streamflow Records	None

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Enhancement Office, Billings, Montana.

U.S. Forest Service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

Nessor, J. U.S. Forest Service, Bighorn National Forest, Sheridan. April 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. October 1987.

References

Acting Regional Director, Fish and Wildlife Service. [Letter to Regional Forester, U.S. Forest Service, Region 2, Denver, Colorado]. 1971 February 17.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Rockett, L. 1970. Proposed enlargement of Cross Creek Reservoir, Bighorn National Forest, 1970. Wyoming Game and Fish Commission, Fish Division, Administrative Report.

Park Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on East Goose Creek, Bighorn National Forest, Sheridan County, Wyoming.
Function	Irrigation
Operators	Park Reservoir Company
Completion Date	Dam was originally constructed in 1892. Storage capacity was enlarged in 1969, and the dam was reconstructed in 1982.
Minimum Streamflow Agreement	A FS special use permit was issued for the 1969 enlargement and contained a clause for the establishment of minimum streamflows. However, the FWS and WGFD recommendations were never officially included in the permit and the FS entered into a verbal agreement with Park Reservoir Company to maintain a minimum flow of 8 cfs. In connection with reconstruction of Park Reservoir Dam, Wyoming House Bill No. 419 of 1981 officially established minimum streamflows below the reservoir in East Goose Creek.
Streamflow Releases	Ninety acre-feet of stored water in Park Reservoir is to be used to sustain a minimum flow in the East Fork of Big Goose Creek equal to 8 cfs or the inflow to Park Reservoir, whichever is less. The 90 acre-feet is to be used to sustain a minimum streamflow when the inflow drops below 4.5 cfs. Five hundred thirty acre-feet of stored water is to be used to augment flushing flows in East Goose Creek of 88 cfs for 72 hours.
Objective	To protect existing downstream aquatic environment and fishery. The flushing flows address channel maintenance.
Information and Methods Used	The FWS applied the Tennant method and recommended a minimum flow of 8 cfs by calculating 25 percent of the average annual flow for the period of 1953 to 1968.
Recommendations	The FWS and WGFD recommended a minimum instantaneous streamflow release of 8 cfs or the inflow, whichever is less, in 1970 after the enlargement was completed and the FS special use permit had been issued. The recommended minimum flow was not incorporated into the FS special use permit. Instead, the FS formed an informal agreement with the Reservoir Company to maintain the 8 cfs.
Streamflow Data	Partial streamflow records for the period of 1971-1978 are available from USGS. However, the records are too incomplete to evaluate maintenance of the 8-cfs minimum streamflow.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Forest Service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

Nessor, J. Bighorn National Forest, Sheridan, Wyoming. April 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. October 1987.

References

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Fish and Wildlife Service, Regional Director. [Memorandum to Regional Forester, U.S. Forest Service, Region 2, Denver, Colorado]. 1970 December 22.

Commissioner, Wyoming Game and Fish Commission. [Letter to Supervisor, Bureau of Sport Fisheries and Wildlife, Missouri River Basin Studies, Billings, Montana]. 1970 December 3.

Mueller, J. 1970. Park Reservoir enlargement, Sheridan County. Wyoming Game and Fish Commission, Fish Division, Administrative Report.

Sawmill Creek Dam and Reservoir
Upper Missouri River Basin

Location	Storage dam and reservoir are located on Sawmill Creek, Bighorn National Forest, Sheridan County, Wyoming.
Function	Irrigation
Operators	Dome Lake Reservoir Company
Completion Date	1972
Minimum Streamflow Agreement	A FS special use permit issued in October 1970 established a minimum streamflow release below Sawmill Reservoir and a maximum streamflow restriction.
Streamflow Releases	A minimum instantaneous flow of 4 cfs will be released at all times except when the inflow to the reservoir is less than 4 cfs, in which case the downstream release will equal the inflow. Maximum releases will be controlled so as not to exceed 20 cfs at any time.
Objective	To provide and maintain optimum fish habitat. Maximum flow restrictions address channel maintenance.

Information and Methods Used	A joint field investigation was conducted by the FS, FWS, and WGFD in 1969. Streamflow records for Sawmill Creek were not available, but flows from a nearby stream were used to estimate flows for Sawmill Creek. Studies were conducted by the Bighorn National Forest hydrologist in 1968 to estimate stream channel capacity. In addition, the Tennant method was applied by FWS biologists.
Recommendations	In 1969 the FWS recommended that the project not be constructed because of its effect on important wildlife habitat, but if it was approved for construction that a minimum instantaneous flow of 4 cfs or the inflow, whichever is less, be released to protect existing aquatic life in Sawmill, West Goose, and Big Goose Creeks. The WGFD also recommended a minimum flow of 4 cfs. The recommendations from the FWS and WGFD were offered before the FS special use permit was issued and prior to construction.
Streamflow Records	None

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Forest service, Bighorn National Forest, Sheridan, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Mueller, J. Retired, Wyoming Game and Fish Department, Sheridan, Wyoming. October 1987.

Nessor, J. Bighorn National Forest, Sheridan, Wyoming. April 1987.

Tennant, D. Retired, U.S. Fish and Wildlife Service, Billings, Montana. October 1987.

References

Commissioner, Wyoming Game and Fish Commission. [Letter to Supervisor, Bureau of Sport Fisheries and Wildlife, Missouri River Basin Studies, Billings, Montana]. 1969 September 25.

Nelson, W., G. Horak, A. Hale, Z. Parkhurst, M. Lewis, D. Wagaman, E. Hoban, and J. Colt. 1976. Assessment of effects of altered stream flow characteristics on fish and wildlife. Part A: Rocky Mountains and Pacific Northwest, Rocky Mountain Region case studies. U.S. Fish Wildl. Serv., Western Energy and Land Use Team, Ft. Collins, CO. FWS/OBS-76/30. 373 pp.

Mueller, J. 1969. Investigation of the Sawmill Reservoir site, Sheridan County. Wyoming Game and Fish Commission, Fish Division, Administrative Report.

Regional Director, Fish and Wildlife Service. [Letter to Forest Supervisor, Bighorn National Forest, Sheridan, Wyoming]. 1969 October 17.

Woodruff Narrows Dam and Reservoir
Great Salt Lake Basin

Location	Storage dam and reservoir are located on the Bear River, Uinta County, Wyoming.
Function	Irrigation
Operators	Woodruff Narrows Reservoir Company

Completion Date	Woodruff Narrows was originally constructed in 1961 and began storing water in 1962. The reservoir was enlarged in 1981.
Minimum Streamflow Agreement	When the original reservoir was constructed, Woodruff Narrows Reservoir Company entered into an agreement with the Utah Division of Wildlife Resources that provided for the use of 4,000 acre-feet of storage to maintain fishery flows in the Bear River during the nonirrigation season (October 1 through April 30). When plans were made to enlarge the reservoir, the WGFD entered into an agreement with the Reservoir Company to release 10 cfs from the reservoir during the irrigation season (May 1 through September 30). The agreement was signed by both parties and became effective on December 4, 1981. Subsequently, the agreement was incorporated into the BLM right-of-way grant. Prior to 1981, there was not a specific instantaneous minimum flow release during the nonirrigation season and no minimum releases during the irrigation season. Since the enlargement of the dam in 1981, it has been regarded that the above two agreements should guarantee a minimum release of 10 cfs from the reservoir on a year-round basis.
Streamflow Releases	The minimum streamflow release from Woodruff Narrows Reservoir is 10 cfs or the inflow to the reservoir, whichever is less.
Objective	To maintain aquatic life in the Bear River below Woodruff Narrows Reservoir.
Information and Methods Used	According to WGFD biologists, the 1981 minimum streamflow agreement was based on professional judgment, observations, and knowledge of streamflows below the reservoir during the period 1967 through 1975. The minimum flow amount was also based on the existing agreement with Utah for 4,000 acre-feet, which roughly provided a minimum flow somewhere between 7 and 10 cfs.
Recommendations	When the project was originally proposed, as a BR project, the FWS in a letter dated September 28, 1960 to the BR, recommended a flow of at least 10 cfs from the dam to the mouth of Twin Creek near the Wyoming-Utah boundary. The WGFD and Utah Department of Fish and Game concurred. In 1979, in response to plans for enlargement, the FWS recommended that a minimum instantaneous discharge of 10 cfs be released from the dam to preserve the important trout fishery in the Bear River. In a letter dated February 13, 1980 to the FWS, the WGFD stated that it would be desirable to have a provision for minimum flows (below the dam) during the period not covered by the Utah agreement, and while no studies had been conducted to determine the actual instream flow needs, flows of 7 to 10 cfs were considered the minimum amount necessary to maintain survival conditions.
Streamflow Records	A USGS gage has been operating below the reservoir since 1961. Only daily streamflows since the 1981 agreement were analyzed, since the Utah agreement did not state a specific minimum flow amount. According to a 1980 letter from WGFD to the FWS, flows downstream from the dam were below 10 cfs during August of 1972, October of water year 1971, the latter part of August and early September in 1968, and October through December of water year 1967. There have been no problems with maintenance of minimum flow releases since the 1981 agreement. However, WGFD biologists do not consider 10 cfs to be an adequate fishery flow. According to information the Department now has, a more appropriate release for the fishery would be somewhere between 50 and 70 cfs. Station: USGS Period of record evaluated: 1982-1985 Percent of record showing minimum streamflow discrepancies: 0

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Enhancement Office, Cheyenne, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Anderson, A. U.S. Fish and Wildlife Service, Cheyenne, Wyoming. January 1987.

Dunning, G. Wyoming Game and Fish Department, Pinedale, Wyoming. July 1987.

References

Area Manager, U.S. Fish and Wildlife Service. [Memorandum to Area Manager, Bureau of Land Management, Kemmerer, Wyoming]. 1979 November 21.

Assistant Director, Wyoming Game and Fish Department. [Letter to Supervisor, U.S. Department of Interior, Fish and Wildlife Service, Billings, Montana]. 1980 February 13.

Chief, Branch of Lands and Mineral Operations, Bureau of Land Management. [Letter to Director, Board of Water Resources, State of Utah, Salt Lake City, Utah]. 1981 July 22.

Miller, D. 1973. Woodruff Narrows Reservoir. Wyoming Game and Fish Commission, Fish Division, Administrative Report.

Regional Director, Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1960 September 28.

Fremont Lake Dam and Reservoir
Green River Basin

Location	Storage reservoir and dam are located on Pine Creek, mostly within Bridger National Forest, near Pinedale in Sublette County, Wyoming.
Function	Irrigation
Operators	Highland Irrigation District
Completion Date	The original dam was constructed in 1930. The dam was replaced and the storage capacity increased in 1986.
Minimum Streamflow Agreement	The COE issued a 404 permit to Highland Irrigation District on December 22, 1986, which required the District to implement and abide by the conditions established in the "Agreement for Operating Fremont Lake Dam and Reservoir." The Agreement was made part of the COE permit. The Operating Agreement was signed by the Irrigation District, Wyoming State Engineer, and WGFD in January of 1986.
Streamflow Releases	In order to maintain the downstream fishery, it was agreed to bypass average inflows through Fremont Lake beginning November 1 of each year until spring runoff, at which time inflows to Fremont Lake would be used to satisfy storage requirements and downstream irrigation rights. Specific flow releases were not included in the agreement, even though they had been recommended by the WGFD and FWS.
Objective	The stated goal in the signed agreement was to maintain the downstream fishery and, according to WGFD biologists, the main purpose was to prevent low winter flows that would be detrimental to the maintenance of a productive stream. The FWS, in a 1968 "Biological Opinion," stated that "the flows the Highland Irrigation District will attempt to maintain should offset potential effects to the endangered fishes of the 800-acre-foot net depletion resulting from replacement of the dam." The endangered

fishes of concern were the Colorado squawfish (*Ptychocheilus lucius*) and the humpback chub (*Gila cypha*).

Information and Methods Used

WGFD biologists observed stream conditions in the fall of 1978 and spring of 1979 when stream discharge was known to be 22 to 23 cfs. Several years of streamflow records, selected at random, were evaluated. Negotiations influenced the final outcome of the agreement, and as a result specific streamflow amounts were not included.

Recommendations

In a 1979 letter to the Mayor of Pinedale, the WGFD recommended a minimum instantaneous flow of 25 cfs in Pine Creek, and a flushing flow of 500 cfs to be provided for two weeks each year. WGFD specified that minimum releases should never be less than the amount of inflow to Fremont Lake.

In a 1985 letter to the COE, the FWS recommended that the COE condition the 404 permit to require a 25-cfs minimum instantaneous flow below Fremont Lake, and require a flushing flow of 500 cfs for a two-week period each year.

The stated flow amounts were not specified in the signed agreement of 1986 or the COE 404 permit. Apparently, the Irrigation District would not accept a specific minimum flow release and the resulting agreement represents a compromise. WGFD biologists admit the agreement is not to their satisfaction and will be difficult to monitor.

Streamflow Records

There is no streamflow gage below Fremont Lake Dam. In addition, due to the lack of a specific flow amount in the agreement, evaluating maintenance of the minimum streamflow agreement is virtually impossible.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Anderson, A. U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming. January 1987.

Annear, T. Wyoming Game and Fish Department, Cheyenne, Wyoming. April 1987.

Stone, M. Wyoming Game and Fish Department, Cheyenne, Wyoming. April 1987.

References

Acting Field Supervisor, Endangered Species, Fish and Wildlife Service. [Letter to Chief, Environmental Analysis Branch, Planning Division, Omaha District Corps of Engineers, Nebraska]. 1986 August 1.

Ecological Services, Field Supervisor. [Letter to District Engineer, U.S. Army Corps of Engineers, Omaha, Nebraska]. 1985 April 10.

Wyoming Water Development Commission. 1981. Report to the Wyoming Legislature and Governor: Rehabilitation of Fremont Lake Dam. Wyoming Water Development Commission.

Dunning, G. Wyoming Game and Fish Department. [Letter to Mayor of Pinedale, Pinedale, Wyoming]. 1979 May 29.

Boulder Lake Dam and Reservoir
Green River Basin

Location	Storage dam and reservoir are located on Boulder Creek, mostly within Bridger National Forest, Sublette County, Wyoming.
Function	Irrigation
Operators	Boulder Irrigation District
Completion Date	The reservoir and dam were originally constructed in 1927, and an enlargement project was completed in 1964.
Minimum Streamflow Agreement	In 1962 the Boulder Irrigation District and the Wyoming Game and Fish Commission signed an agreement that established minimum flow releases from Boulder Lake Reservoir.
Streamflow Releases	During the nonirrigation season (September 1 through April 25) a minimum flow of 5 cfs, whether direct or from storage allocated for fish, wildlife, and related recreational aspects (1,620 acre-feet annually), will be bypassed through Boulder Lake Reservoir. During the irrigation season (April 25 through September 1) the District will bypass a minimum flow of 10 cfs from direct flow or from the storage allocated for fish and wildlife.
Objective	To maintain, preserve, and propagate the fish populations of the State inhabiting Boulder Creek.
Information and Methods Used	According to WGFD biologists, systematic methods were not applied to determine the minimum streamflow release. The minimum flow amounts were based on professional judgment and negotiations with the irrigation district.
Recommendations	The minimum streamflow releases were determined by WGFD biologists. According to the 1962 agreement, Federal and State agencies assumed some of the construction costs; however, a record of FWS recommendations pursuant to the FWCA could not be located in FWS files. It is possible that the FWS did not offer any official recommendations because the 1962 agreement already provided for the enhancement of fish and wildlife benefits.
Streamflow Records	Station: USGS Period of record evaluated: 1965-1973 Percent of record showing streamflow discrepancies: 19.3 Percent of record showing streamflow discrepancies greater than 10 percent: 14.7 Percent of record showing streamflow discrepancies greater than 25 percent: 9.3 Percent of record showing streamflow discrepancies greater than 50 percent: 1.6 Percent of record showing streamflow discrepancies greater than 75 percent: 0.0 According to WGFD biologists, there have been some problems in the past concerning the proper placement of the drop board that bypasses the minimum flow amount. In recent years there has not been a problem with maintenance of the minimum flows. However, the WGFD does not consider the flow amounts to be adequate for the downstream fishery and would like to see a flow two to three times higher.

Agency Files Providing Project Information

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Wyoming State Engineers Office, Cheyenne, Wyoming.

Personal Communications

Dunning, G. Wyoming Game and Fish Department, Pinedale, Wyoming. July 1987.

References

Dunning, G. Wyoming Game and Fish Department. [Letter to M. Stone, Wyoming Game and Fish Department, Cheyenne, Wyoming]. 1986 June 10.

Fontenelle Dam and Reservoir
Seedskadee Project
Green River Basin

Location Storage dam and reservoir are located on the Green River, 24 miles southeast of La Barge in Lincoln County, Wyoming.

Function Fontenelle Reservoir is operated for multiple uses including municipal, industrial, power production, flood control, and a downstream fishery and wildlife refuge.

Completion Date Fontenelle Dam was completed in 1964, but the embankment was damaged after the initial filling in 1965. The reservoir was drawn down and repairs were completed in 1967 and the reservoir was refilled in 1968. Fontenelle Powerplant began operation in 1968.

Operators Bureau of Reclamation

Minimum Streamflow Agreement There has been a minimum streamflow release from Fontenelle Reservoir since it was completed. The minimum releases are stated in the 1970 Interim Operating Rules for Fontenelle Reservoir and in the BR's 1974 Repayment Contract with the State of Wyoming.

Streamflow Releases The 1970 Operating Rules state that:

> "A continuous flow of at least 300 cfs be maintained at all times in the channel immediately below Fontenelle Dam for the benefit of fish life habitat. This is an absolute minimum reached only under unusual circumstances...A normal minimum release of 500 cfs, which is the power plant capacity at minimum power head, shall be the discretionary minimum."

Conditions under which the stated minimum releases can be reduced are included in the Operating Rules.

The 1974 Repayment Contract has provisions to encourage that the 300-cfs minimum release from Fontenelle be "delivered as a continuous, reasonably uniform, daily flow" to the Interstate 80 highway crossing of the Green River.

Objective To maintain fish life habitat. According to WGFD biologists, prior to impoundment of waters by Fontenelle Dam the Green River supported carp, suckers, and catfish. The construction of Fontenelle has improved water quality and a trout fishery has developed.

Information and Methods Used A joint study was conducted in 1964 by FWS and WGFD biologists to determine minimum streamflow requirements. Flow releases of 400, 300, and 200 cfs were observed and photographed for changes in river conditions.

A more detailed study was conducted in 1973 by WGFD and FWS biologists to determine and recommend an optimum flow regime to maintain the existing fishery. This study was in response to proposed sales of municipal and industrial water from Fontenelle. Flow releases of 1,600, 800, 500, and 300 cfs were evaluated, and hydraulic studies were conducted using permanent transects to measure changes in depth, velocity, and stream surface.

Recommendations

When the Seedskadee project was proposed in the 1950's, the FWS, in a 1958 report on the fish and wildlife resources, did not recommend minimum streamflows below the project. It was stated that "reduced streamflow is of insignificant value." After the 1964 streamflow study was conducted the WGFD, in a 1964 Administrative Report, stated that "nothing less than 300 cfs should be considered as providing adequate minimum conditions for the maintenance of a sport fishery." This statement was meant to indicate that a flow of 300 cfs should only be considered as a short term survival flow, but it was interpreted as being a recommendation for a 300-cfs minimum release below Fontenelle.

Following the detailed study of 1973, the FWS and WGFD recommended a flow regime that would sustain the existing fishery. During November through March a winter survival flow of 500 cfs was recommended. If this flow could not be maintained, 300 cfs could be released, but for no longer than a 30-day period. During the period of April through October, a production flow of 800 cfs was recommended with flushing flows up to 1,600 cfs when necessary. The flow regime recommended by FWS and WGFD was not accepted by the BR because at the time the proposed water sale contract did not provide the necessary quantity of water.

In a letter dated January 18, 1974 to the Wyoming State Engineer, the WGFD stated that they would support the water sale contract because it would guarantee minimum flow provisions (300 cfs) and that "while these flow levels will be experienced during drought conditions, substantially greater flows will be available during normal water years."

Streamflow Records

Station: USGS gage downstream from Fontenelle Dam
Period of record evaluated: 1964-1985

300 cfs
Percent of record showing streamflow discrepancies: 1.9
Percent of record showing streamflow discrepancies greater than 10 percent: 1.1
Percent of record showing streamflow discrepancies greater than 25 percent: 0.3
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

Streamflows of at least 500 cfs have been maintained about 90 percent of the time.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming.

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Johnson, K. Wyoming Game and Fish Department, Green River Wyoming. October 1987.

Sersland, H. U.S. Bureau of Reclamation, Upper Colorado River Region, Salt Lake City, Utah. June 1987.

References

Banks, R., J. Mullan, R. Wiley, and D. Dufek. 1974. The Fontenelle Green River trout fisheries-considerations in its enhancement and perpetuation, including test flow studies of 1973. Wyoming Game and Fish Commission.

U.S. Fish and Wildlife Service. 1958. A report on fish and wildlife resources in relation to the plan for Seedskadee Project, Green River Subbasin, Wyoming. U.S. Department of Interior, Fish and Wildlife Service, Albuquerque, New Mexico.

Wyoming Game and Fish Commission. 1964. An evaluation of data and observations on trial flow-releases in the Green River below Fontenelle Dam. Wyoming Game and Fish Commission, Administrative Report.

U.S. Bureau of Reclamation. 1974. Final environmental statement, proposed contract for sale of municipal and industrial water from Fontenelle Reservoir, Seedskadee Project, Wyoming. U.S. Department of Interior, Bureau of Reclamation, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 1982. Seedskadee Project, Wyoming: Lincoln and Sweetwater Counties. U.S. Government Printing Office, Denver, Colorado.

Meeks Cabin Dam and Reservoir
Lyman Project
Green River Basin

Location	Storage dam and reservoir are located on the Blacks Fork River, Uinta County, Wyoming.
Function	Irrigation
Operators	Meeks Cabin was constructed and sponsored by the BR. After construction the project was turned over to the Bridger Valley Water Conservancy District for operation. Operation of Meeks Cabin is subject to the guidelines established by the BR in its operating procedures for the Lyman Project.
Completion Date	1971
Minimum Streamflow Agreement	Minimum streamflow releases from Meeks Cabin were established in the 1962 BR Definite Plan Report for the Lyman Project, and subsequently became part of the BR's operating procedures.
Streamflow Releases	Operational criteria call for a minimum streamflow release of 10 cfs during the non-irrigation season (approximately September 30 through May 15) from Meeks Cabin Reservoir, with the understanding that releases during the irrigation season would always be at least 10 cfs due to releases for downstream irrigators.
Objective	To preserve the fishery in the Blacks Fork downstream from Meeks Cabin.
Information and Methods Used	The minimum streamflow was based on professional judgment, field observations, streamflow records for the period 1930 to 1960, and negotiations.
Recommendations	The FWS, WGFD, and Utah Fish and Game Department initially recommended a minimum streamflow release of 20 cfs. This amount was not feasible under the BR's operating constraints, and thus the amount was changed to 10 cfs in the FWS Coordination Act Report dated November 2, 1962. To compensate for the lower minimum flow release, acquisition of public access for an eight- to ten-mile reach was recommended. In 1971, after the project was constructed, the WGFD conducted a streamflow study downstream from Meeks Cabin. The results indicated that 10 cfs was not adequate for the fishery, and WGFD recommended a minimum flow of 50 cfs. No changes in the minimum flow release were made after the WGFD's recommendation.
Streamflow Data	Station: USGS Period of record evaluated: 1971-1985

Percent of record showing streamflow discrepancies: 11.1
Percent of record showing streamflow discrepancies greater than 10 percent: 8.1
Percent of record showing streamflow discrepancies greater than 25 percent: 3.3
Percent of record showing streamflow discrepancies greater than 50 percent: 0.1
Percent of record showing streamflow discrepancies greater than 75 percent: 0.04

There is no upstream gage; thus, we were not able to evaluate how often the upstream flows were less than the required minimum release.

According to the WGFD, there have been problems with streamflow releases in the past. Apparently the flows were being regulated according to the needs of downstream irrigators. The WGFD contacted the BR in 1986 after the problem was noticed, and the BR has since contacted the operators to insure that the minimum streamflows will be released.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Region 4, Salt Lake City, Utah.

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

U.S. Fish and Wildlife Service, Enhancement Office, Cheyenne, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Johnson, K. Wyoming Game and Fish Department, Green River, Wyoming. October 1987.

Wiley, B. Wyoming Game and Fish Department, Laramie, Wyoming. October 1987.

References

Area Manager, U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1980 May 6.

Regional Director, Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1962 November 2.

U.S. Bureau of Reclamation. 1962. Lyman Project, Wyoming, Definite Plan Report, November 1962. U.S. Department of Interior, Bureau of Reclamation, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 1983. Lyman Project, Wyoming: Uinta County. U.S. Government Printing Office, Denver, Colorado.

Wiley, B. 1972. Black's Fork River volume flow observations, Uinta County, Wyoming. Wyoming Game and Fish Commission.

Stateline Dam and Reservoir
Lyman Project
Green River Basin

Location	Storage dam and reservoir are located on the East Fork of the Smiths Fork River, Wasatch National Forest, Utah. Stateline Dam is approximately 0.5 miles south of the Utah-Wyoming boundary; thus, downstream flows in the Smiths Fork River in Wyoming are regulated by water releases from Stateline Reservoir.

Function Irrigation

Operators Stateline Dam was sponsored and constructed by the BR as part of the Lyman Project. After completion the project was turned over to the Bridger Valley Conservancy District for operation. Operation of Stateline is subject to conditions established by the BR in the Definite Plan Report and operating criteria for the Lyman Project.

Completion Date 1979

Minimum Streamflow Agreement The minimum streamflow releases for Stateline were established in the BR Definite Plan Report Supplement dated October 1976. Subsequently, the minimum streamflow releases have been incorporated into the BR's operating criteria.

Streamflow Releases A minimum streamflow of 10 cfs or the natural streamflow will be maintained in the East Fork of the Smiths Fork River downstream from Stateline Dam during the nonirrigation season. The understanding was that streamflows during the remainder of the year would always be greater than 10 cfs due to releases for irrigation. Information from BR and FWS correspondence since the 1962 Definite Plan Report indicates that the 10 cfs is to be maintained at all times.

Objective To maintain the downstream fishery, especially during the winter months.

Information and Methods Used The minimum streamflow amount was a result of professional judgment, field observations, streamflow records above the dam site, and negotiations.

Recommendations When the Lyman Project was originally planned it included a dam on the East Fork of the Smiths Fork River at China Meadows. The FWS, with the concurrence of WGFD and Utah Fish and Game Department, recommended a minimum flow of 8 cfs below China Meadows in their FWCA report of 1962. When the dam site was changed to Stateline, the recommendations were changed to a 10-cfs minimum streamflow release. The new recommendation was incorporated into the BR Definite Plan Report Supplement of 1976.

Streamflow Records Station: USGS
Period of record evaluated: 1979-1985 (no records were available for the winter months)

Percent of record showing streamflow discrepancies: 13.6
Percent of record showing streamflow discrepancies greater than 10 percent: 12.6
Percent of record showing streamflow discrepancies greater than 25 percent: 10.9
Percent of record showing streamflow discrepancies greater than 50 percent: 3.0
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

Upstream flow records are not available; thus, we were not able to evaluate how often inflows to the reservoir were below 10 cfs.

According to the WGFD and BR, there have been problems associated with releasing the minimum streamflow amount in the past. Apparently the past problems have been related to winter access to Stateline Dam. The gates were normally set in the fall to release the minimum flow, or natural inflow to the reservoir, but when streamflows changed the amount released also changed and the operators were not on site, nor could they access the site, to adjust the gate settings.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Region 4, Salt Lake City, Utah.

U.S. Fish and Wildlife Service, Salt Lake City, Utah.

U.S. Fish and Wildlife Service, Enhancement Office, Cheyenne, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Dufek, D. Wyoming Game and Fish Department, Green River, Wyoming. October 1987.

Sersland, H. U.S. Bureau of Reclamation, Environmental Section, Salt Lake City, Utah. June 1987.

References

Area Manager, U.S. Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1980 May 6.

Regional Director, Fish and Wildlife Service. [Memorandum to Regional Director, Region 4, Bureau of Reclamation, Salt Lake City, Utah]. 1962 November 2.

U.S. Bureau of Reclamation. 1962. Lyman Project, Wyoming, Definite Plan Report, November 1962. U.S. Department of Interior, Bureau of Reclamation, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 1976. Lyman Project, Wyoming, Definite Plan Report supplement, October 1976. U.S. Department of Interior, Bureau of Reclamation, Upper Colorado Region, Salt Lake City, Utah.

U.S. Bureau of Reclamation. 1983. Lyman Project, Wyoming: Uinta County. U.S. Government Printing Office, Denver, Colorado.

City of Cheyenne Stage II Water Supply Project
Green River and Lower Missouri River Basins

Location	The Cheyenne Water Supply Project involves two storage dams and reservoirs, Hog Park and Rob Roy Reservoirs, located in the Lower Missouri River Basin. In addition, the project diverts water from several small streams including: Nugget, Little Beaver, Camp, and Horse Creeks located in the Lower Missouri River Basin; and Rose, Green Timber, North Fork Little Snake, Ted, Third, Deadman, Harrison, Soloman, Rabbit, and West Branch Creeks located in the Green River Basin. Project structures are within the Medicine Bow National Forest, Albany and Carbon Counties, Wyoming.
Function	The project supplies municipal water for the City of Cheyenne. Existing Cheyenne Stage I developments include three water collection and storage systems. The Little Snake River system collects water from the west side of the Continental Divide and releases it into Hog Park Creek upstream from Hog Park Reservoir. The water is then returned to the North Platte system in an amount equivalent to that diverted by the Douglas Creek system. The Douglas Creek system diverts water from the North Platte to Rob Roy Reservoir and then through a pipeline into Lake Owen. Water is taken from Lake Owen through a pipeline to Middle Crow Creek drainage, the third system. From Middle Crow Creek, water is stored in Crystal Lake Reservoirs for municipal use by the city of Cheyenne. Under the Stage II plan, Hog Park and Rob Roy Reservoirs were enlarged and more diversions constructed.
Operators	Cheyenne Public Utilities
Completion Date	The completion dates of Stage II facilities with minimum streamflow requirements are as follows:

Green River Basin (Little Snake River system)

1985 Rose Creek Diversion
1983 Green Timber Creek Diversion
1984 North Fork of the Little Snake Diversion
1984 Ted Creek Diversion
1985 Third Creek Diversion
1985 Deadman Creek Diversion
1985 Harrison Creek Diversion
1987 Soloman Creek Diversion
1986 Rabbit Creek Diversion
1987 West Branch Creek Diversion

Lower Missouri River Basin (Douglas Creek system)

1986 Hog Park Reservoir (originally constructed in 1966)
1986 Rob Roy Reservoir (located on Douglas Creek and originally constructed in 1966)
1987 Nugget Gulch Diversion
1987 Little Beaver Creek Diversion
1987 Camp Creek Diversion
1987 Horse Creek Diversion (originally constructed in 1962 for Stage I and subsequently modified under Stage II plans).

Minimum Streamflow Agreement

Minimum streamflow releases were established in a 1982 FS easement. The minimum streamflows were also made a part of the COE 404 permit issued on January 20, 1987.

Streamflow Releases

The following minimum streamflows, or natural flows, are to be maintained below the diversion structures. In addition, flushing flows are required for a 72-hour period during spring runoff.

Stream Diversion	Minimum Streamflow	Flushing Flow
Rose Creek	0.75	9.0
Green Timber Creek	1.0	14.0
North Fork Little Snake	2.0	30.0
Ted Creek	1.0	19.0
Third Creek	1.0	11.0
Deadman Creek	2.0	35.0
Harrison Creek	1.0	9.0
Soloman Creek	1.0	12.5
Rabbit Creek	1.5	18.0
West Branch	3.5	92.0
Nugget Gulch	0.2	4.5
Little Beaver Creek	0.35	7.0
Camp Creek	0.2	2.0
Horse Creek	0.2	0.0

A minimum instantaneous flow of 15 cfs is required in Hog Park Creek below the dam at all times, with a maximum flow of 200 cfs, except when the natural flow is greater than 200 cfs. A minimum instantaneous flow of 5.5 cfs is required in Douglas Creek below Rob Roy Reservoir at all times. The maximum flow restriction is 130 cfs, except when the natural flow is greater than 130 cfs.

Objective

To provide and maintain favorable conditions of waterflows, and to maintain riparian habitat and downstream fisheries. The minimum flows for streams in the Little Snake River system also addressed cutthroat spawning habitat. Flushing flows address channel maintenance.

Information and Methods Used

The majority of the field studies were conducted from 1976 to 1979 by FS and WGFD biologists. Minimum streamflows were based on historical streamflow records, fish population studies, habitat analyses, and R-2 Cross transects.

Recommendations

The recommendations offered by the FWS in 1980 (U.S. Fish and Wildlife Service 1980) were based on findings by Jesperson (1980) and Wesche et al. (1977), and concurred with the flushing and maintenance flows determined by WGFD. The recommended flows did not differ from the final flows listed for the above streams.

A minimum flow of 5 cfs below Hog Park Reservoir, or the inflow, was recommended by the FWS in 1962 during the planning for Stage I facilities. The recommendation was not accepted at that time.

Streamflow Records

Except for Hog Park and Douglas Creeks, the diversion structures are fairly complex and unique to this project. The structures are designed to release the minimum streamflow before water is diverted by the City of Cheyenne's system. These structures alleviated the need to install continuous recording stream gages below each diversion. The structures require a fair amount of manpower each year, as the valves have to be manually set. Flow records for Douglas Creek are available through Cheyenne Utilities, but we were not able to acquire them for our analysis. Flow records for Hog Park Creek below the reservoir were acquired from the State Engineer's office.

Station: Streamflow data from below Hog Park Dam were acquired from the State Engineers office.
Period of record evaluated: September 1986-October 1987

Percent of record showing streamflow discrepancies: 0.0

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Anderson, A. U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming. January 1987.

Schmal, N. U.S. Forest Service, Medicine Bow National Forest, Laramie, Wyoming. December 1986.

Stone, M. Wyoming Game and Fish Department, Cheyenne, Wyoming. June, July 1987.

Struby, R. Banner and Associates, Inc., Laramie, Wyoming. October 1987.

Wilcox, M. U.S. Forest Service, Medicine Bow National Forest, Laramie, Wyoming. July 1987.

References

Jesperson, D. 1980. Instream flow determination for streams affected by Stage I and II of the City of Cheyenne water development project in the Douglas Creek drainage and supplemental flow recommendations in the North Fork of the Little Snake River drainage. U.S. Forest Service, U.S. Dept. of Agriculture.

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U.S. Fish and Wildlife Service. 1980. Fish and Wildlife Service Coordination Act report on the Cheyenne water supply project, Wyoming. U.S. Fish and Wildlife Service, Billings, Montana.

Wesche, T., D. Reiser, W. Wichers, and D. Wichers. 1977. Fishery resources and instream flow recommendations for streams to be impacted by Cheyenne's proposed Phase II development. Water Resources Research Institute, University of Wyoming, Laramie, Wyoming.

Sand Lake Dam and Reservoir

Lower Missouri River Basin

Location	Storage dam and reservoir are located on Deep Creek, Medicine Bow National Forest, Carbon County, Wyoming.
Function	Irrigation
Operators	Wheatland Irrigation District
Completion Date	Wheatland Irrigation District first acquired Sand Lake and completed modifications in 1956.
Minimum Streamflow Agreement	A FS special use permit issued in December 1961 established minimum streamflow releases below the dam.
Minimum Streamflow Releases	The permit stipulates that the outlet works shall be set so that the flow in Deep Creek at a point 300 feet below the dam will be maintained at a volume equivalent to or greater than the minimum flow at the same point before construction of the dam (8 cfs).
Objective	A specific objective was not stated in the special use permit. However, it appears from the wording used in the permit that the minimum flow is to maintain existing downstream aquatic conditions.
Information and Methods Used	A record of the information used to determine the minimum flow could not be located. It appears from information in the permit that knowledge of streamflows was used as a basis for the 8-cfs minimum flow requirement.
Recommendations	A record of the recommendations offered by the FWS and WGFD could not be located in FWS or WGFD files.
Streamflow Records	None According to the FS hydrologist for the Medicine Bow National Forest, there has never been a problem with maintaining the minimum streamflow below Sand Lake.

Agency Files Providing Project Information

U.S. Forest Service, Medicine Bow National Forest, Laramie, Wyoming.

Wyoming State Engineers Office, Cheyenne, Wyoming.

Personal Communications

Wilcox, M. U.S. Forest service, Medicine Bow National Forest, Laramie, Wyoming. June 1987.

References

U.S. Forest Service. 1961. Special Use Permit, Wheatland Irrigation District. Medicine Bow National Forest, Laramie, Wyoming.

Kortes Dam and Reservoir
Kortes Unit
Lower Missouri River Basin

Location	Storage dam and reservoir are located on the North Platte River in Carbon County, Wyoming.
Function	The Kortes Unit includes Kortes Dam, Reservoir, and Powerplant. Seminoe Dam and Powerplant (Kendrick Project) are located about 2 miles upstream from the Kortes Unit. Water releases from power generation at Seminoe flow into the small Kortes Reservoir and then through Kortes Powerplant.
Completion Date	The Kortes Unit was authorized by the Flood Control Act of December 22, 1944, Public Law 534. Construction on the dam began in 1946 and was completed in 1951. Kortes Powerplant began operating in 1950, coinciding with the first storage of water in Kortes Reservoir.
Operators	Bureau of Reclamation
Minimum Streamflow Agreement	The minimum streamflow below Kortes Dam was established by Public Law 92-146 (85 Stat. 414), which authorized operational modifications for fishery conservation. The BR began releasing the minimum flow in 1968, although final approval from Congress was in 1971. According to WGFD biologists, the minimum streamflow release was instituted as a result of water cut-offs due to power peaking operations in the early 1960's. Power peaking operations combined with warm summer weather resulted in severe fish kills during at least two summers in the early 1960's. The WGFD and FWS joined efforts and, with the cooperation of the BR, conducted studies and presented the findings and justification for minimum streamflows to the Secretary of the Interior.
Streamflow Releases	Public Law 92-146 requires a minimum streamflow in the reach of the North Platte between Kortes Dam and the headwaters of Pathfinder Reservoir of 500 cfs, provided that "sufficient water is available to maintain such minimum flow, without a resultant adverse effect on other water users who have valid rights to the use of this water: Provided further, that when sufficient water is not available to operate in this manner, water will be reserved for hydroelectric peaking power operations on a four-hour daily, five-day-week basis and any remaining water will be reserved for conservation of the fishery resource."
Objective	To conserve the fishery resource between Kortes Dam and the headwaters of Pathfinder Reservoir.
Information and Methods Used	During 1963, WGFD and FWS biologists evaluated test flow releases provided by the BR from Kortes Reservoir. Stream conditions in the ten-mile reach between Kortes and Pathfinder were evaluated with respect to flows releases of 300, 500, 800, 1,200, 1,800, and 2,800 cfs.
Recommendations	From the findings of the 1963 study, the WGFD determined that 800 cfs was the desired minimum streamflow for this reach of the Platte River. However, realistically there was not enough water to provide this amount; thus, 500 cfs was recommended as an adequate flow for the fishery. According to WGFD biologists, 800 cfs was greater than the mean historic flow. In a 1966 memorandum, prepared under the authority of the FWCA, the FWS officially recommended a minimum flow of 500 cfs to the BR.

Streamflow Records

Station: BR gage located downstream from Kortes Dam
Period of record evaluated: 1969-1986

Percent of record showing streamflow discrepancies: 2.2
Percent of record showing streamflow discrepancies greater than 10 percent: 0.1
Percent of record showing streamflow discrepancies greater than 25 percent: 0.01
Percent of record showing streamflow discrepancies greater than 50 percent: 0.0

There have been no major problems concerning streamflows below Kortes Dam. According to WGFD biologists, flows have been reduced in the past by request from the department in order to conduct stream work. Emergency situations such as drowning accidents have also resulted in reduced streamflows.

Agency Files Providing Project Information

U.S. Bureau of Reclamation, Projects Office, Loveland, Colorado.

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Anderson, A. U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming. January 1987.

Peterson, L. Retired, Wyoming Game and Fish Department, Casper, Wyoming. October 1987.

Wichers, B. Wyoming Game and Fish Department, Casper, Wyoming. July 1987.

References

U.S. Bureau of Reclamation. 1983. Pick-Sloan Missouri Basin Program, Kortes Unit, Oregon Trail Division. U.S. Government Printing Office.

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Gray Reef Dam and Reservoir
Glendo Unit
Lower Missouri River Basin

Location

Storage dam is located on the North Platte River downstream from Alcova Reservoir and Dam, about 27 miles southwest of Casper, Natrona County, Wyoming.

Function

Gray Reef is operated to reregulate water releases from power generating facilities (Alcova Powerplant) located about two miles upstream. Gray Reef Dam is one of the facilities associated with the BR's Glendo Unit. Other facilities include Glendo Dam, Reservoir and Powerplant (downstream from Gray Reef), and Fremont Canyon Powerplant (upstream from Gray Reef). Alcova Dam, Reservoir and Powerplant, also located upstream from Gray Reef, are part of the BR's Kendrick Project.

Completion Date Construction of Gray Reef was authorized in 1958 by Public Law 85-695 (72 Stat. 687) to provide acceptable streamflows for irrigation, municipal, and fish and wildlife benefits between Alcova and Glendo Dams. Construction began in 1959 and was completed in 1961.

Operators Bureau of Reclamation

Minimum Streamflow Agreement Fish and wildlife interests were included in the authorizing legislation for Gray Reef Dam and Reservoir in 1958. The minimum river flow below Gray Reef Dam was established in the 1959 Feasibility Report that was made a part of Public Law 85-695 (72 Stat. 687), which authorized the project. The minimum river flow was subsequently incorporated into the BR's operating criteria for the Glendo Unit.

Streamflow Releases The official minimum release from Gray Reef Reservoir is 330 cfs. According to the BR's operating criteria, flows will normally be at least 500 cfs. However, if upstream storage becomes depleted, or if releases would result in a loss of irrigation water for downstream users, the releases may be less than 330 cfs.

Objective The 1959 Feasibility Report stated that the 330 cfs was recommended as a release that would be adequate to maintain fish habitat as well as satisfy other downstream requirements. Downstream requirements included enough water flow to dilute municipal and industrial effluent from the city of Casper in order to maintain water quality.

Information and Methods Used During the spring of 1958, the WGFD conducted a series of test flow releases from Alcova Reservoir and evaluated river conditions downstream of the proposed Gray Reef Dam site. Flows of 300, 800, 1,300, 2,800, and 3,800 were evaluated from photographs of the river channel and cross section measurements at different stations.

Recommendations The WGFD, from the findings of the 1958 test flow study, recommended that at least 300 cfs be released in the river downstream from Alcova Dam to provide spawning and food production habitat for fish. In a 1958 memorandum, the FWS, with cooperation from the WGFD, recommended a minimum flow of 330 cfs. The FWS's recommendation was also based on results from the 1958 test flow study.

Streamflow Data Station: USGS
Period of record evaluated: 1961-1985

Percent of record showing streamflow discrepancies: 0.8
Percent of record showing streamflow discrepancies greater than 10 percent: 0.5
Percent of record showing streamflow discrepancies greater than 25 percent: 0.4
Percent of record showing streamflow discrepancies greater than 50 percent: 0.1
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

According to WGFD biologists, there have been no problems in maintaining flows below Gray Reef. The only deviations from the minimum flow that WGFD biologists were aware of have been due to emergency situations including drowning accidents, flood control, and repair work on project facilities.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Billings, Montana.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Anderson, A. U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming.

Peterson, L. Retired, Wyoming Game and Fish Department, Casper, Wyoming. October 1987.

Wichers, B. Wyoming Game and Fish Department, Casper, Wyoming. July 1987.

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Peterson, L., and T. Leik. 1958. A fisheries evaluation of North Platte River water flows resulting from releases at Alcova Reservoir, spring 1958. Wyoming Game and Fish Commission.

U.S. Bureau of Reclamation. 1980. Pick-Sloan Missouri Basin Program, Glendo Unit, Oregon Trail Division. U.S. Government Printing Office.

U.S. Government Printing Office. 1959. Gray Reef Dam and Reservoir, Wyoming, letter from the Secretary of Interior transmitting a report on Gray Reef Dam and Reservoir, Glendo Unit, Wyoming, Missouri River Basin Project, pursuant to Public Law 85-695. Washington, DC.

Grayrocks Dam and Reservoir
Lower Missouri River Basin

Location	Storage dam and reservoir are located on the Laramie River, near Wheatland in Platte County, Wyoming.
Function	Grayrocks primarily provides water for power generation at Laramie River Station and irrigation.
Operators	Basin Electric Power Cooperative
Completion Date	1981
Minimum Streamflow Agreement	Final minimum streamflow releases below Grayrocks dam in the Laramie River were established in the 1978 "Agreement of Settlement and Compromise" entered into by Basin Electric Power Cooperative, Tri-State Generation and Transmission Association, City of Lincoln, State of Nebraska, National Wildlife Federation, Nebraska Wildlife Federation, National Audubon Society, Powder River Basin Resource Council, Laramie River Conservation Council, Justice Department, Rural Electrification Association, and the Army Corps of Engineers. This agreement was basically the result of a court ruling that required the developers to provide more adequate measures to protect downstream resources along the Platte River.
Streamflow Releases	During normal operations (50,000 to 104,000 acre-feet of storage) the agreement is to deliver to the mouth of the Laramie River 40 cfs October through March, 50 cfs during April, and 40 cfs or 75% of the natural flow (whichever is greater) May through September. In addition, operations do not require the project to release more than 200 cfs at any time or more than 12,000 acre-feet during any month. When storage in Grayrocks is below 50,000 acre-feet the flow at the mouth of the Laramie River should be at least 20 cfs October through March, and 40 cfs April through September.
Objective	To maintain a fishery in the Laramie River between Grayrocks Dam and mouth of the Laramie River, and to maintain habitat for waterfowl, whooping cranes, and sandhill cranes farther downstream on the Platte River in Nebraska.

Information and Methods Used

During 1976, FWS biologists used "Ecological Planning and Evaluation Procedures" (as described in a letter to the COE dated 1976 September 29) to evaluate terrestrial and aquatic habitats. The Tennant or Montana method was also applied to determine fishery flows.

Recommendations

In a memorandum dated February 18, 1976 to the Office of Environmental Project Review in Washington, DC, the FWS pointed out several inadequacies in the draft Environmental Impact Statement for Grayrocks, including the impacts of altering streamflows below the reservoir site. Subsequently, the FWS in cooperation with the WGFD conducted an analysis of the proposed project. In a letter dated September 29, 1976 to the COE, the FWS stated (with agreement from the WGFD) that no less than 30 cfs instantaneous flow should be maintained below the dam April 1 through September 30 (30 percent of the historic mean annual flow), and that no less than 20 cfs instantaneous flow be maintained October through March.

On June 29, 1977 an agreement was reached between the FWS, WGFD, and a representative for Basin Electric Power Cooperative that established the following flow regime:

- August through March, 15 cfs or the inflow to the reservoir, whichever is less, will be released
- October through March the project will maintain 20 cfs at the mouth of the Laramie River
- April through May at least 30 cfs will be released from the reservoir, and during the months of April through September, 40 cfs will be maintained at the mouth of the Laramie River
- when storage in Grayrocks is below 50,000 acre-feet, releases can be reduced to maintain 40 cfs at the mouth of the Laramie River April through September, and 20 cfs at the mouth of the river October through March.

Between 1977 and December of 1978, the State of Nebraska, the National Wildlife Federation, and others filed suit to block construction of Grayrocks due to inadequacies in the Final EIS. On October 2, 1978 the courts ruled in favor of the plaintiffs, and in December 1978 the involved parties entered into an "Agreement of Settlement and Compromise." The agreement, among other things, provided more adequate minimum streamflows.

Streamflow Records

Station: USGS gage located near the mouth of the Laramie River
Period of record evaluated: 1981-1985

Percent of record showing streamflow discrepancies: 32.0
Percent of record showing streamflow discrepancies greater than 10 percent: 27.7
Percent of record showing streamflow discrepancies greater than 25 percent: 22.2
Percent of record showing streamflow discrepancies greater than 50 percent: 7.3
Percent of record showing streamflow discrepancies greater than 75 percent: 0.0

There is no streamflow gage immediately below the dam; we therefore evaluated flows at the mouth of the Laramie River only. In addition, there are no upstream flow records; thus, we were not able to evaluate how often upstream flows were less than the minimum flow amounts. Flow records were evaluated according to normal operating conditions due to lack of information concerning reservoir storage levels.

According to the WGFD there have not been any serious problems with the maintenance of streamflows below Grayrocks Reservoir.

Agency Files Providing Project Information

U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming.

Wyoming Game and Fish Department, Cheyenne, Wyoming.

Personal Communications

Anderson, A. U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, Cheyenne, Wyoming. January 1987.

Lloyd, J. Formerly with the U.S. Fish and Wildlife Service, Billings, Montana. July 1987.

Miller, D. Wyoming Game and Fish Department, Laramie, Wyoming. October 1987.

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U.S. Fish and Wildlife Service, Area Manager, Billings, Montana. [Letter to District Engineer, U.S. Army Corps of Engineers, Omaha, Nebraska]. 1976 September 29.

U.S. Fish and Wildlife Service, Regional Director. [Letter to District Engineer, U.S. Army Corps of Engineers, Omaha, Nebraska]. 1977 July 29.

U.S. Fish and Wildlife Service, Regional Director. [Letter to District Engineer, U.S. Army Corps of Engineers, Omaha, Nebraska]. 1976 December 10.

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August 1988

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U.S. Department of the Interior
Fish and Wildlife Service
Research and Development
Washington, DC 20240

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

All known water projects in Colorado, Montana, and Wyoming with streamflow agreements and data on streamflows below the project were examined to assess the frequency of discrepancies between agreed-to and actual flows. A total of 73 water development projects were identified, involving 119 locations with minimum streamflow agreements. Of the 119 locations, only 61 had streamflow data. Of these 61 locations, 54 exhibited flows below those established in streamflow agreements on at least some occasions; 28 locations had flows 25% of the established agreement or lesss. Several locations showed chronic deviations. Actual flows were lower than agreed-to flows for 20% or more of the time at 17 of the 61 locations. These data are summarized by State, agency, and type of agreement in the main report.

17. Document Analysis a. Descriptors
Water resources

b. Identifiers/Open-Ended Terms
Instream flows
Mitigation
Streamflow agreements

c. COSATI Field/Group

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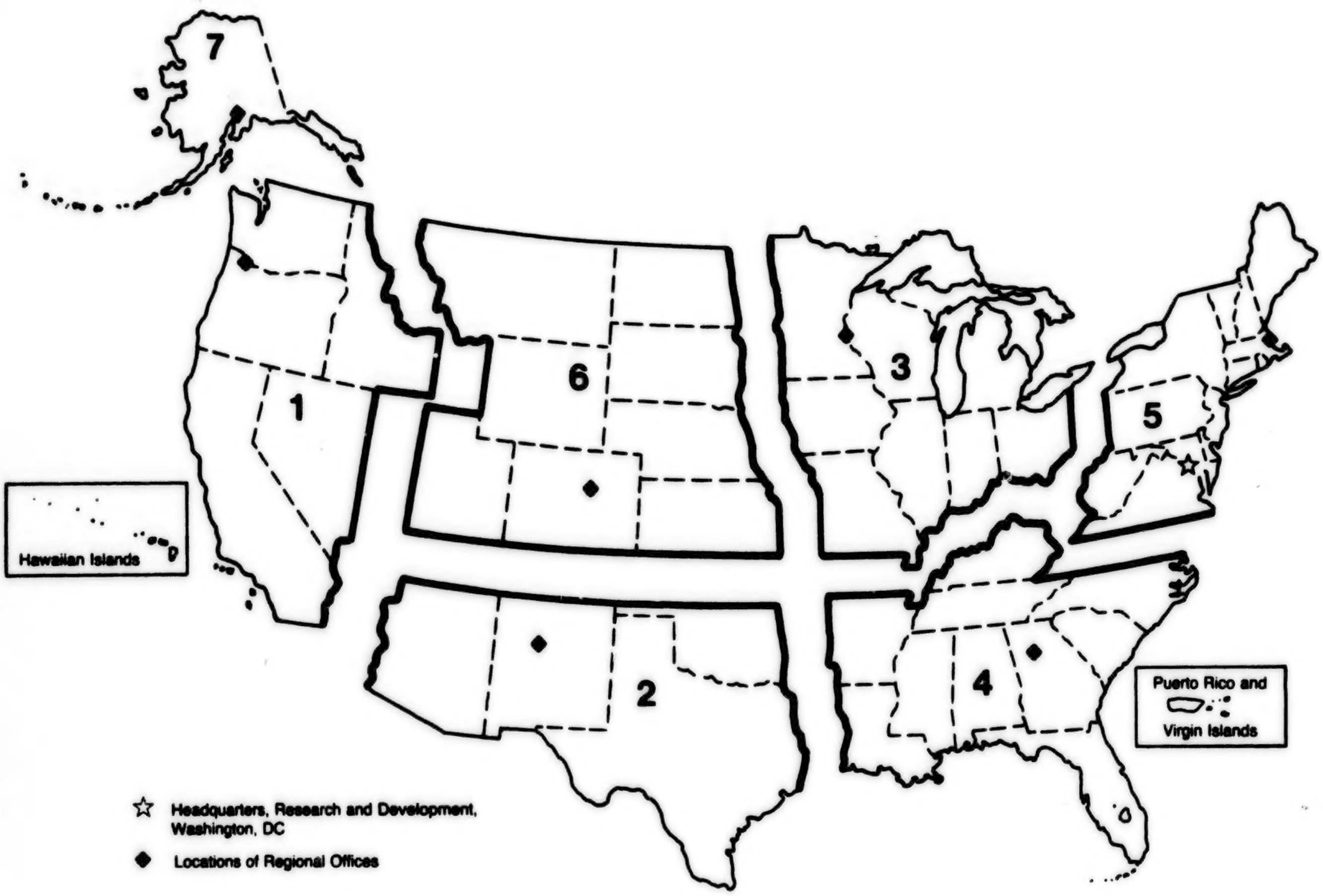
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Hawaiian Islands
Puerto Rico and
Virgin Islands
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◆ Locations of Regional Offices

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